Skills, Transaction Costs, and Offshored Tasks - Implications for Wage Inequality in Developing Countries

Manisha Goel*

Department of Economics

The Ohio State University

May 2012

Abstract

This paper develops a model to show that the nature of offshored tasks performed by workers in developing countries can generate diverging trends in inequality between and within skill groups. Production of a good requires a combination of tasks that differ in their skill intensities and transaction costs. Skills differ along two dimensions - verifiable skills needed to carry out tasks with low transaction costs, like those that can be cheaply routinized or overseen, and unverifiable, problem solving or analytical skills needed for tasks with high transaction costs. Firms in advanced countries minimize total costs by offshoring low skilled and/or low transaction cost tasks. Increased offshoring of such tasks increases the demand for verifiable skills and reduces the demand for unverifiable skills in developing countries. This causes widening of wage gaps between groups of workers with different levels of verifiable skills but a narrowing of wage gaps within them. The predictions from the model are examined using household data for India. Consistent with the model, I find that between 1983 and 2005, wage inequality grew between skill groups, as measured by education and experience, but declined within each group. This occurred despite an increase in the relative supply of observable skills, suggesting that the demand for various skills grew differently.

*This project would not be successful without the guidance and encouragement of Bruce Weinberg. I thank David Blau and Joseph Kaboski who gave me valuable suggestions.

1 Introduction

Contrary to the textbook Heckscher-Ohlin theory, following trade liberalization, wage inequality has been increasing in developing countries abundant in low-skilled labor. A large literature[1] attributes this trend to trade induced skill-biased technological change or "skill enhancing trade" (SET). With liberalization of their trade regimes, developing countries increase their imports of modern machinery developed in advanced countries. This imported equipment embodies skill-biased technology, increasing the productivity and wages of skilled relative to unskilled workers. Studies[2] also show that increase in wage inequality can also result from offshoring of tasks from developed countries that are low-skill intensive from their perspective but are performed by relatively skilled workers in developing countries. Both SET and offshoring increase the demand for skills, leading to growth in wage inequality between *and* within skill groups in developing countries, mirroring the evolution of wage structures in developed countries like the United States.

However, a few studies (see Jensen and Kletzer (2005), Acemoglu and Autor (2010), and Oldenski (2012)) show that firms offshore both high-skill and low-skill intensive tasks if they can be easily routinized, summarized in a few instructions, and/or monitored. This suggests that transactions costs of tasks (besides transportation, communication and other trade costs) constitute an important factor determining the set of tasks that are offshored. In this paper, we develop a model of trade in tasks that require two types of skills - "verifiable" (like education and experience), and "unverifiable" (like problem solving and analytical skills). Tasks that are more intensive in verifiable skills are associated with lower monitoring or transaction costs, relative to tasks intensive in unverifiable skills. Firms in advanced countries offshore the set of tasks that minimizes the total factor and transactions costs of production. I show that in developing countries, this results in offshoring of tasks that are less intensive in unverifiable skills and hence involve low transaction costs. This leads to increased demand for easily verifiable skills like education, but reduced demand for softer, analytical or problem solving skills that are not easily verifiable by employers. A key implication is that wage inequality increases between education or skill groups, but falls within them. The result holds when I additionally allow for SET.

I examine this prediction empirically using household level data for India over the

[1] See, for example, Robbins (1996), Berman, Somanathan and Tan (2006), Chamarbagwala (2006, 2009), Kijima (2006), Kugler and Verhoogen (2009), Goldberg and Pavcnik (2004), Attanasio, Goldberg and Pavcnik (2004), Frias, Kaplan and Verhoogen (2006), Verhoogen (2008), Mazumdar and Quispe-Agnoli (2004), Pavcnik (2002, 2003), Pavcnik, Blom, Goldberg and Schady (2004), Kang and Hong (2002), Tan (2000), and Burstein, Cravino, and Vogel (2011).

[2] Feenstra and Hanson(1996), Trefler and Zhu (2005).

period 1983 to 2005. India is a large developing country that phenomenally liberalized its trade regime following a financial crisis in 1991. Following liberalization and other structural reforms,[3] India rapidly integrated with the world economy. Indeed, service exports from India grew at an average rate of 35% between 2000 and 2005. The data reveal that wage inequality has increased in India in the post liberalization years. Relative wages of highly educated groups of workers have increased despite an increase in their relative supply. This growing demand for skilled workers is also reflected in upgrading of the skill composition of the workforce within all two-digit industries. Defining demographic groups according to measures of education, experience, gender, marital status, caste group, religion, state of residence, and area of residence (rural/urban), while inequality is increasing overall and between groups, it is falling within these groups - as reflected in a decline in residual wage inequality over time.

The model that we develop has several novel features that contribute to our understanding of trade in tasks and its labor market implications. Thus far, skills have been modeled as a uni-dimensional concept. Workers have been considered to be heterogeneous along this unidimensional continuum of skills (see, for example, Grossman and Rossi-Hansberg (2008), Zhu and Trefler (2005), amongst others). Moreover, although tasks have been considered to be heterogeneous in their costs of offshoring, as in Grossman and Rossi-Hansberg (2008), a distinction has not been made between trade costs (like transportation and communication) and monitoring costs. However, workers do not differ along a single skill dimension. Moreover, as transportation and communication costs plummet with technological advances, other transaction costs, like monitoring and overseeing, become a more significant part of offshoring costs. This is the first study to develop a model that incorporates these two features to endogenously generate the observed patterns of offshoring to developing countries and show that it leads to divergent movements in wage inequality between and within skill groups. Models of task content of production and trade have begun to be developed only recently and have not been used thus far to analyze the labor market implications for developing countries.

This study also relates to the broader literature that analyzes wage trends in developing countries with increasingly liberal trade regimes. The interest in studying trends in the developing world stems from the fact that an increase in wage inequality following trade liberalization in these countries is opposite to the prediction of the textbook Heckscher-Ohlin-Samuelson theory[4]. Researchers have argued that as developing coun-

[3] A brief overview of these reforms is provided in Appendix A.

[4] According to the theory, developing countries abundant in unskilled labor export goods and services intensive in relatively unskilled labor to developed economies and import skill-intensive products. Thus, following trade, the demand for unskilled workers should increase relative to skilled workers leading to

tries increasingly liberalize their trade regimes, they import capital equipment that embodies skill-biased technology developed in the North, i.e., skill-biased trade. This phenomenon has been theoretically modeled (eg. Burstein, Cravino and Vogel (2011), Parro (2011)) and empirically documented in several studies (eg. Robbins (1996), Chamarbagwala (2006), among others). Other channels by which trade with advanced countries can lead to skill upgrading and rising skill-premia in developing countries have also been analyzed. See, for example, Verhoogen (2008), and Trefler and Zhu (2005). However, these studies have also not analyzed residual or within-group inequality trends in developing countries.

Finally, this paper contributes to the growing empirical literature that examines the labor market trends in India. Previous studies (see, for example, Berman, Somanathan and Tan (2005), Chamarbagwala (2006), and Topalova (2004)) have also found that the overall wage inequality is increasing and the growing returns to education have contributed significantly to the widening of the wage structure. The rising skill premium in India has been attributed by some studies to skill enhancing trade (eg. Kijima, 2005). However, this opinion is contradicted by others who relate it to indigenous SBTC not influenced by trade (Berman, Somanathan and Tan, 2005), those who relate it to trade in general (Acharya, 2006), and yet others who think of it as explained by trade induced SBTC in combination with other factors like increased foreign direct investment (FDI), deregulation in general (Chamarbagwala, 2006), and capital-skill complementarities (Berman, Somanathan and Tan, 2005). Mishra and Kumar (2005) on the other hand think that trade in fact led to reduced wage inequality. However, these studies have not considered the pattern of inequality within education and experience groups and the trends in residual wage inequality. My finding of declining inequality within skill groups points to a more nuanced set of factors influencing the Indian labor market besides skill enhancing trade.

The rest of the paper is organized as follows. Section 2 presents a sketch of the model that we will develop in the future. Section 3 discusses the data I use for my analysis. Section 4 examines the predictions of the model by documenting the trends in wage inequality, labor supply, and employment of various skill groups in India. Section 5 concludes.

a reduction in wage inequality in less developed economies.

2 Model

Consider two countries - developed North (N) and developing South (S) - that trade in tasks. Workers in both countries are endowed with two types of skills - verifiable ($v \in 1, 2, 3, ...$) and unverifiable ($u \in (0, 1)$). Thus, workers belong to groups identified by v, and workers within each group are heterogeneous in their endowments of u. The wage, W of any worker depends on his/her endowment of v and u. The factor markets are perfectly competitive.

Perfectly competitive firms in the North (South) produce a homogeneous good Y_N (Y_S) using a production technology that combines a continuum of tasks, t that vary in their intensities of v and u. Each task performed in the North (South) differs in its transaction cost, $C_{Nt}(v, u)$ ($C_{St}(v, u)$). The transaction cost is strictly increasing in u. Firms in the North can choose whether to perform a task domestically or to offshore it to the South. The iceberg trade cost is the same for all tasks, and is denoted by δ. Thus, while performing a task t in the North costs $h_{Nt}W_N(v, u) + C_{Nt}(v, u)$, to offshore it to the South costs $\delta[h_{St}W_S(v, u) + C_{St}(v, u)$. We assume that minimizing the cost of producing the good requires minimizing the cost of every task separately.

We assume that the North is relatively more abundant in verifiable skills than the South, so that, for any given level of unverifiable skills, $\overline{u}$ and $v_1 > v_2$, $\left(\frac{W(v_1,\overline{u})}{W(v_2,\overline{u})}\right)_N < \left(\frac{W(v_1,\overline{u})}{W(v_2,\overline{u})}\right)_S$. Further, for given levels of verifiable and unverifiable skills, $\overline{v}$ and $\overline{u}$, $C_{Nt}(\overline{v}, \overline{v}) \leq C_{St}(\overline{v}, \overline{v})$.

Claim: Given this structure, for a task involving a given level of v, we can find a threshold level of C below which the task can be offshored.

3 Data

In this section, I provide a brief overview of the data that I use to examine the model's predictions for the developing country whose workers perform the offshored tasks. My principal data source is the Employment and Unemployment schedule of the National Sample Survey of India - a nationally representative household level survey that is conducted approximately every five years. I use data from repeated cross-sections for the years 1983, June 1987-July 1988, June 1993-July 1994, June 1999-July 2000 and June 2004-July 2005.[5] Thus, the sample covers the period 1983 to 2005. Wages are deflated by national consumer price index separately in urban and rural areas (1983=100). These

[5] In presenting results, I refer to these survey years as 1983, 1988, 1994, 2000 and 2005.

indices were obtained from the online database of the Reserve Bank of India (India's central bank).

Following Katz and Murphy (1992), I create separate wage and employment samples. The wage sample consists of all persons between the ages of 15 and 65 years who were either working or unemployed in the previous year in either a principal or subsidiary capacity[6] and were engaged in regular or casual wage employment in the reference week. Besides requiring individuals to be in the labor force in the previous year, I also need to add this latter qualifier of being gainfully employed in the reference week because the survey reports wages only for the reference week. Self employed workers[7] are excluded from this sample as there is no wage or income measure for them. By restricting my sample to people who were in the labor force in either principal or subsidiary capacity, I include only those who had some degree of continuous attachment to labor force in the wage analysis (see Katz and Murphy (1992)). On the other hand, the employment sample consists of all persons between the ages of 15 and 65 years,[8] who worked in either principal or subsidiary capacity during the previous year, or in the reference week, irrespective of whether they worked for wages or were self employed. All workers, regardless of whether or not they were self employed, are included in the employment sample to get as close a measure as possible of the aggregate labor supply in the economy in each year.

The survey asks people to report up to four different economic activities that they were involved in during the reference week. Hence, some persons in my wage and employment samples may appear more than once under different jobs. I give each job held by such people a weight equal to the inverse of the number of jobs that the person reports to have held during the reference week. This procedure ensures that all people in the wage and employment samples receive an equal weight. Wage data are not top or bottom coded. To remove outliers, I drop the top and bottom 1% of the wage sample in each year. However, in the first two years, respectively, about 6% and 45% of the persons in the wage sample reported zero wages.[9] Thus, considerably more than a total of 2% of

[6]Principal activity refers to the activity that a person was engaged in for the longest duration of time during the previous year. Subsidiary activity is the activity engaged in for the next longest duration of time.

[7]Around 32% of the sample is constituted by self-employed individuals.

[8]Results using wage and employment samples that include people aged 18-65 are similar.

[9]In both years, these individuals are disproportionately uneducated (about 60% of those reporting zero wages), males (more than 80%), living in rural areas (around 91%), and predominantly engaged in the primary sector (nearly 55%) or as domestic helps (close to 18%). It is possible that these people are mostly agricultural labor or household servants who are on informal contracts and do not get money wages at regular intervals. In later years, individuals who reported zero wages share similar demographic characteristics. It is not clear, however, why they constitute such a large proportion of the sample interviewed in 1983 and 1988 and comparatively negligible proportions (less than 2%) in later years of the survey.

the sample was dropped in these two years. Results for these two years should, hence, be treated with caution. Wages are reported for each wage and salaried activity engaged in during the reference week. The survey does not provide information on hours of work. Instead, we know whether the person worked for half or full day, on each of the seven days of the reference week. Half day is recorded if the person worked 1-4 hours on a day and full day is recorded if the person worked more than 4 hours on a day. For my analysis, I use log real weekly wages as the variable of interest.[10]

The survey reports persons' level of education as the highest level of education completed. Using this information, I divide all people in the sample into five education categories: uneducated (this includes individuals who are illiterate or literate without formal schooling or those who did not complete primary education), primary educated (typically 5 years of schooling), middle schooled (typically 8 years of schooling), high school graduates (typically 12 years of schooling), and college graduates and above (typically 15 years of education for non-technical degrees, and 16 years for technical degrees like engineering). I construct dummies for highest level of education completed. A standard measure of potential labor market experience is age-typical years of schooling-6. However, since a large proportion of the sample consists of uneducated persons, this measure will result in implausibly high levels of experience for such persons. To address this problem, labor market experience acquired between the ages of six and twelve is not counted and that gained between the ages of twelve and eighteen counts as half the potential experience acquired between those ages. Thus, the formula that I use to construct a measure of potential experience is:

$$\begin{aligned}
\text{Potential experience} &= \frac{1}{2}Age - 6 && if\ \ S \leq 6\ \ \&\ \ Age \geq 18 \\
&= \frac{1}{2}(Age - S) - 6 && if\ \ S \geq 6\ \ \&\ \ Age \leq 8 \\
&= Age - 15 && if\ \ S \leq 6\ \ \&\ \ Age > 18 \\
&= \left(Age - \frac{1}{2}S\right) - 12 && if\ \ S > 6\ \ \&\ \ Age > 18
\end{aligned}$$

where S refers to typical years of schooling. I also use persons' age as a measure of

[10]So as to not lose out on the variation in hours worked by persons in the sample, other researchers have allotted 4 work hours to all those who are recorded to have worked half day and 8 hours to all those who are recorded to have worked a full day. However, I find that the results arrived at using hourly wages where hours are defined in this way are different from those when I use weekly wages in my analysis. Also, I regressed log real weekly wages on a vector of dummy variables that took the value of 1 if a person worked full time on any given day in the reference week and 0 otherwise, a vector of dummy variables that took that value of 1 if a person worked half time on any given day in the reference week and 0 otherwise (not having worked, thus, is the excluded category) and other variables. The coefficients on these dummy variables suggest that working full day fetched only ten percent more wage than working half day. So the data suggest that a full day amounts to only about ten percent more hours of work than a half day, on average. Results using hourly wages where hours are defined as 4 for a half day and 4.4 for a full day are qualitatively similar to those using weekly wages.

labor market experience. Results are robust to the experience measure used. I describe the results using age in the text and include the results using potential experience in appendix B.

Marital status is coded using three categories: never married (reference group), currently married, and widowed, divorced, or separated. I also construct dummies for the state that the person resides in, whether the person lives in a rural or urban area, the religion followed, and whether the person belongs to a socially disadvantaged group.

My analysis abstracts from some issues specific to a developing country like India such as labor immobility across sectors and geographic regions, the consequent labor market segmentation, and disguised unemployment. Topalova (2004) provides evidence to argue that there is considerable geographical and intersectoral labor immobility in India and that it has not reduced over time. Dutta (2005) incorporates labor market segmentation in her analysis using the regular-casual worker dichotomy. Regular workers are defined as those who are on a formal contract receiving wages at periodic intervals. Casual workers are those who do not have any regular employment but instead look for miscellaneous jobs from time to time and get paid intermittently without any formal contracts. Dutta (2005) argues that casual wage workers constitute the informal sector, regular wage workers constitute the formal sector, and that the labor market is segmented along this dimension. Although, given the the National Sample Survey design, this is the only dichotomy one can use to address the issue of segmentation, it may not be an appropriate approach. Fields (2009), summarizing the theoretical literature on segmented labor markets, says that "...for dualism to exist, different wages must be paid in different sectors to comparable workers." In the light of this statement, one cannot justifiably argue that the labor market in India is segmented between regular and casual wage workers. Systematic differences in their skills may well be the reason why they find regular or casual wage jobs in the first place. The data reveal that casual and regular workers are systematically different in their educational and other demographic characteristics. Casual workers are overwhelmingly rural, uneducated males engaged in the primary sector. In contrast, regular workers are predominantly urban males with high school and college degrees, with a majority being employed in services. According to my estimates, on average, casual workers earn around twenty percent less than regular workers, controlling for observable skills and other demographic characteristics.

Tables 1, 2 and 3 present some descriptive statistics for India as revealed by the National Sample Survey. Table 1 shows that the groups of self-employed and those working in the informal[11] sector have always been larger than the group of workers in the

[11] Casual wage workers are defined as working in the informal sector.

formal[12] sector. There is no visible upward or downward trend in these proportions over time. Also, not surprisingly for India, a much larger fraction of formal sector workers are high school and college graduates than the corresponding fractions in the informal sector. Informal sector workers are overwhelmingly from the uneducated group, although their share has been falling in both the formal and the informal sectors over the sample period (Table 2). Evidently from table 3, while agriculture is the biggest employer of workers, services are the next largest employers and manufacturing industries lag behind. The proportion of workforce employed in construction almost doubled between 1983 and 2005. Amongst services (not shown in the table), the group of financing, insurance, real estate and business services (which include information technology services) witnessed the maximum growth in employment share from 0.9% of the labor force in 1983 to 7.6% in 2005.

4 Wage and Employment Trends

We are now ready to document the evolution of wages and employment of various skill and demographic groups in India. I first show the secular trends in absolute and relative wages of several education and experience groups of the labor force in India. Next, I will show the employment trends for these groups to assess the supply and demand for workers belonging to different groups. Finally, I will document the trends in inequality within groups.

4.1 Overall and Between Group Inequality

Figure 1 shows that overall inequality increased in India over the entire sample period, although everyone has gained in real terms. The left panel traces the average real weekly wages of the people at the ninetieth, fiftieth and tenth percentiles of the wage distribution in each year. It shows that inequality increased the most in the upper half of the real weekly wage distribution. While their real weekly wage stood at Rs. 126 in 1983, it increased by over 150% to Rs. 320 by 2004-05. The 50th and 10th percentile workers also gained in real terms over the period, but their gains were much smaller compared to workers at the 90th percentile. The right panel shows us the change in log real weekly wages by percentile between 1983 and 2005 between the tenth and ninetieth percentiles of the log real weekly wage distributions[13]. Workers beyond the 80th percentile increasingly

[12] Regular wage and salaried workers are defined as working in the formal sector.

[13] To make the left panel of figure 1, I first calculated the log real weekly wages of workers at each percentile (between the 10th and 90th) of the wage distribution separately for 1983 and 2005. The

gained much more than workers at the lower percentiles.

Returns to education have increased over time. Figure 2 plots the returns to college education relative to high school education, high school relative to middle school, middle school relative to primary education, and primary education relative to no education. These relative returns are estimated by taking the differences between the coefficient on a given education dummy and the coefficient on the next lower education dummy as obtained from a regression of real log weekly wages on interactions of education and year dummies, a quartic in age, and controls for gender, states of residence, area of residence, marital status, religion, and caste groups. The figure shows that returns to college education steadily grew relative to high school education over the sample period. While college premium over high school education was less than the returns to high school education relative to middle school education between 1983 and 1994, it was more than the latter during the decade of 2000. Returns to middle school education relative to primary education and of primary education relative to no schooling also grew slightly over the 22-year period.

Returns to experience also grew over the years. Figure 3 presents relative wages of workers aged 46-55 years relative to younger workers between the ages of 26 and 35 separately for each education level. Dividing the sample into five ten-year age groups (15-25, 26-35, 36-45, 46-55 and 56-65), I regress log real weekly wages on interactions of education, age group and year dummies while including controls for gender, states of residence, area of residence, marital status, religion, and caste groups. Estimates from this regression are used to construct this figure. Relative wages of older workers are higher among high school graduates than among college graduates. Amongst both high school and college graduates, older workers steadily gained over younger workers. Even among the lower education groups, wages of older workers grew relative to those of younger workers, but the rate of growth was slower.

4.2 Employment

The increase in the overall wage inequality and the growth in the returns to education occurred despite a significant increase in the supply of higher educated workers. Among both males and females, the proportion of the labor force constituted by highly educated groups has been increasing steadily. Figure 4 shows trends in the labor supply of all education groups separately by gender.[14] It is evident that for both males and females,

differences in the percentile wages of the two years were then plotted in the graph.

[14]Women have always constituted a very small fraction of the labor force in India. However, their participation in the labor market has been increasing with time.

the proportion of middle, high school and college educated workers consistently increased over the sample period. The supply of uneducated workers has fallen substantially over the 22-year period, although the vast majority of both men and women in the labor force continues to be uneducated.

The fact that the relative wages of more highly educated workers have increased even as their supply has increased indicates increased demand for such workers. Indeed, the equilibrium levels of employment of high school and college educated workers have increased over time. Furthermore, this has occurred disproportionately within two digit industries rather than between them[15]. Table 6 decomposes the overall shift in employment of workers in different education groups into the shares caused by shifts between and within two digit industries. The table shows that between 1983 and 2004-05, the employment of uneducated workers fell by 17.39 percentage points with that for primary educated workers increasing slightly. Employment of middle school, high school and college educated workers increased by 5.8, 6 and 4.8 percentage points respectively. Except for primary educated workers (for whom employment shifts both within and between industries were small and similar in magnitude), these shifts were driven overwhelmingly by shifts within two digit industries.

These trends in wage inequality, returns to skill, and the supply and demand for highly educated workers in India are qualitatively similar to the labor market trends documented for several developed countries over the last four decades (with the exception of the U.S. labor market in the 1970s when the wages of college graduates fell relative to those of high school graduates). A few other studies for India (see, for example, Berman, Somanathan and Tan (2005) and Chamarbagwala (2005)) also present similar findings. These trends are consistent with the predictions of both the SET and offshoring hypotheses. However, I now present trends in inequality within skill groups that contradict both hypotheses.

4.3 Within Group Inequality

Overall inequality can be decomposed into inequality between various demographic or skill groups and inequality within these groups. Figure 5 reveals that while inequality increased between various education groups, it fell within most education groups. Each curve shows the gains made by people with a given level of education over the sample period. Between 1983 and 2005, college graduates who were at lower percentiles of the college wage distribution gained more than college graduates at higher percentiles.

[15] According to Berman, Somanathan and Tan (2005), the increased employment of higher educated groups of workers in the manufacturing sector was overwhelmingly due to increased employment within even 3 digit manufacturing industries.

Thus, within the group of college graduates, wage inequality fell. The same holds true for primary educated people as well as for middle educated and uneducated (not shown in figure 5). Among high school graduates, persons around the middle of the high school wage distribution gained less over the 22 year period than those at the two ends of the spectrum. Also, those at the higher end gained slightly more than people at the lower end of the distribution. But comparing the curves for different education groups, we find that inequality increased between these education groups; college graduates gained more than high school graduates, who in turn gained more than the primary educated (except around the middle percentiles). This divergence in the movement of inequality between and within groups holds for more narrowly defined groups too, as I show next.

Another way of looking at this phenomenon is to consider movements in the raw and residual wage distributions as obtained from a linear regression framework. Consider the following regression framework:

$$Y_{it} = X_{it}\beta_t + \epsilon_{it}$$

Here, Y_{it} refers to the natural logarithm of the real weekly wage of person i in year t. The vector of regressors X_{it} includes education dummies, a quartic in age fully interacted with education dummies, and dummies for gender, marital status, urban residence, state of residence, religion and caste groups. Estimating separate regressions for each year allows the coefficients on all variables to vary over time. The residuals are captured in ϵ_{it}. The distribution of Y_{it} reflects the overall inequality in the economy in year t. The distribution of $X_{it}\beta_t$ gives us a measure of between group inequality where various groups are identified by the included regressors. The distribution of the residuals from the estimated regression equation includes a measure of inequality within groups. Graph A of Figure 6 plots the difference in wages of workers at the 90th and 10th percentiles in the raw and residual wage distributions of each year. Evidently, the 90-10 raw wage differential increased between 1983 and 1988, then fell until 1999-2000 and then rose again to 2.46 in 2004-05. The residual 90-10 differential fell substantially between 1983 and 2005. The rising vertical gap between the two curves shows that inequality has been increasing between groups. Again, the 90-50 raw wage differential, i.e., overall inequality in the upper half of the wage distribution, (Graph B, Figure 6) rose over time while the corresponding residual wage differential fell. Graph C shows that overall inequality in the lower half of the wage distribution has fallen over time as also has the residual wage distribution[16]. Moreover, these inequality trends are not driven by differences in

[16]Note that in 1983 and 1988, the residual 50-10 differential is higher than the raw 50-10 differential. It seems that in these two years, linear regression overestimates the slope for the lower half of the wage

characteristics of cohorts. Defining synthetic six-year birth cohorts, I track the 90-10 raw and residual wage differentials over the years for each cohort separately. All cohorts witnessed similar trends in inequality. See figure 9 in appendix A.

Next, I employ the decomposition method suggested by Juhn, Murphy, and Pierce (1993) to examine the extent to which the residual wage inequality dampens the overall inequality. The decomposition also provides us with the contributions of changes in observable characteristics and their prices to the changes in overall inequality. Table 4 decomposes the total change in the 90-10, 90-50 and 50-10 raw wage differentials between 1983 and 2005 into the shares caused by changes in observed quantities, changes in prices of observable characteristics and changes in residuals. While both quantities and prices contributed to the increase in 90-10 differential, the changes in residuals acted to reduce it. Increased inequality in the upper half of the distribution was more due to changes in prices than due to changes in quantities, while residuals slightly dampened it. However, changes in quantities led to an increase while changes in prices and residuals led to a fall in the inequality in the lower half of the distribution so that in net terms the inequality increased by 0.027 between 1983 and 2005.

We can further assess the contribution of each estimated price and observable quantity to the change in overall distribution of log real weekly wages. To do this, I decompose the change in the variance of the log real weekly wage distribution between 1983 and 2005 into changes in variances of observable quantities (keeping prices constant) and changes in variances of estimated coefficients (keeping quantities constant). In particular, keeping prices at their mean level over the entire sample period, I estimate the contribution of education levels as they prevailed in 1983 to log real weekly wages of the same year. I do the same using education levels of 2005. The difference in the variance of these two estimates gives me an estimate of the proportion of the change in the variance of log real weekly wages that is attributable to the change in the variance of educational distribution between 1983 and 2005. Following a similar method, I obtain the contribution of changes in variances of other quantities to the change in the variance of log real weekly wages over the sample period. In order to get an estimate of the contribution of changes in variances of prices, I employ an analogous method where I keep quantities at their 1983 levels and let the prices change between 1983 and 2005. The results are presented in table 5. The variance of log real weekly wages increased by 0.11 between 1983 and 2005. Decomposing this into variances of quantities and prices, we find that the largest

distribution. A possible approach of quantile regressions cannot be applied here as the solution does not converge. Even spline regressions that allow the intercept and slope of the regression line to change across education levels or across area of residence (rural/urban) give similar results.

contribution to this change in dispersion came from the change in the variance of returns to education. The distribution of education levels across the sample was the next largest contributor. Dispersion in returns to experience also increased. While the distribution of people between urban and rural areas did not change much over the period, the dispersion in returns to urban residence declined by 0.02 points. Once again, I find that the variance of the residual distribution fell substantially by 0.16 between 1983 and 2005.

5 Conclusion

In this paper, I develop a model of trade in tasks that differ in their intensities of verifiable and unverifiable skills. I show that as trading costs fall, the firms in advanced countries, increasingly offshore tasks that are relatively low verifiable skill intensive for them, but are high verifiable skill intensive for the developing countries, but are still low in transaction costs. This leads to greater between and within group wage inequality in the advanced country. However, in the developing country, it leads to greater inequality between verifiable skills groups but lower wage inequality within each group. A comprehensive documentation of wage and employment trends in India between 1983 and 2005 supports this finding. In future work, I will develop the model further and provide more empirical evidence to support the theoretical predictions.

Table 1: Proportions of Formal and Informal Sectors and Self-Employed Workers

Year	Formal	Informal	Self Employed
1983	13.85	27.85	32.87
1988	14.26	28.82	38.20
1994	13.51	30.25	28.97
2000	14.32	32.17	28.27
2005	14.38	27.76	30.20

All numbers are weighted percentages of the employment sample. Weights used: sampling weights.
Formal sector includes people working for a regular wage or salary during the reference week. Informal sector includes people working for a casual wage during the reference week.
Note that the numbers for each year do not sum to 100%. The remaining sample is constituted by unpaid family workers, those unemployed in the reference week but employed during the previous year, and those who did not work during the reference week due to sickness or some other reason.

Table 2: Educational Composition of Workers in Formal and Informal Sectors

Year	Education	Formal	Informal[a]
1983	No School	33.85	84.39
	Primary School	13.76	10.05
	Middle School	15.46	4.37
	High School	24.08	1.04
	College and Above	12.76	0.08
1988	No School	32.93	83.19
	Primary School	13.80	10.03
	Middle School	13.49	5.02
	High School	25.19	1.63
	College and Above	14.49	0.12
1994	No School	23.97	78.75
	Primary School	10.73	10.61
	Middle School	15.62	7.36
	High School	29.75	3.07
	College and Above	19.91	0.19
2000	No School	19.48	73.17
	Primary School	9.92	11.23
	Middle School	16.45	10.36
	High School	31.63	4.83
	College and Above	22.45	0.31
2005	No School	18.43	67.58
	Primary School	11.54	14.26
	Middle School	17.02	12.82
	High School	25.12	4.75
	College and Above	27.86	0.57

[a]All numbers are weighted percentages of the employment sample. Weights used: sampling weights. Formal and informal sectors are defined as in table 1.

Table 3: Industry Composition of Labor Force

Industry	1983	2005
Agriculture, Hunting, Forestry, Fishing, and Mining and Quarrying	63.62	56.14
Manufacturing	12.09	12.47
Construction	3.23	6.03
Services	21.06	25.36

All numbers are weighted percentages of the employment sample. Weights used: sampling weights. Numbers are based on the industries that individuals were employed in during the reference week.

Table 4: Decomposition of Changes in Overall Inequality
1983 - 2005

Differential	Total Change	Observed Quantities	Observed Prices	Residuals
90-10	0.295	0.267	0.171	-0.143
90-50	0.268	0.100	0.175	-0.007
50-10	0.027	0.167	-0.005	-0.136

Table 5: Changes in Variances of Wages, Observable Quantities and Prices

1983 - 2005

Variables	Total Change	Quantity	Price
Log Real Weekly Wage	0.106		
Education		0.060	0.095
Age		-0.002	0.029
States		0.014	-0.011
Sex (Male=1)		0.000	0.007
Urban Residence		0.000	-0.024
Marital Status		0.000	0.003
Religion		0.000	0.000
Caste (Disadvantaged=1)		0.010	0.080
Residual	-0.155		

Table 6: Industry Based Demand Shift Indices: 1983-2005

Education group	Employment Shares in 1983	Overall Shift	Between Industry Shift	Within Industry Shift
No School	66.64	-17.39	-2.06	-15.33
Primary School	13.15	0.86	0.50	0.36
Middle School	9.78	5.79	0.57	5.22
High School	7.55	5.99	0.64	5.35
College	2.89	4.76	0.36	4.40

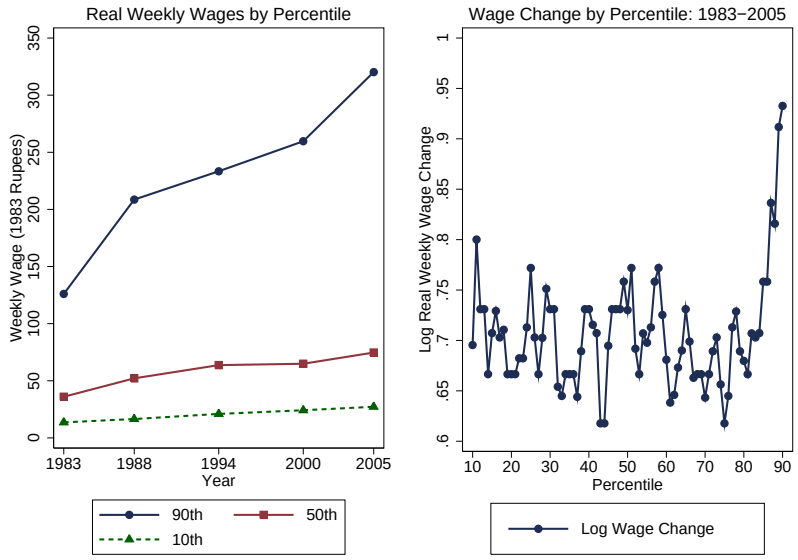

Figure 1: Overall Inequality

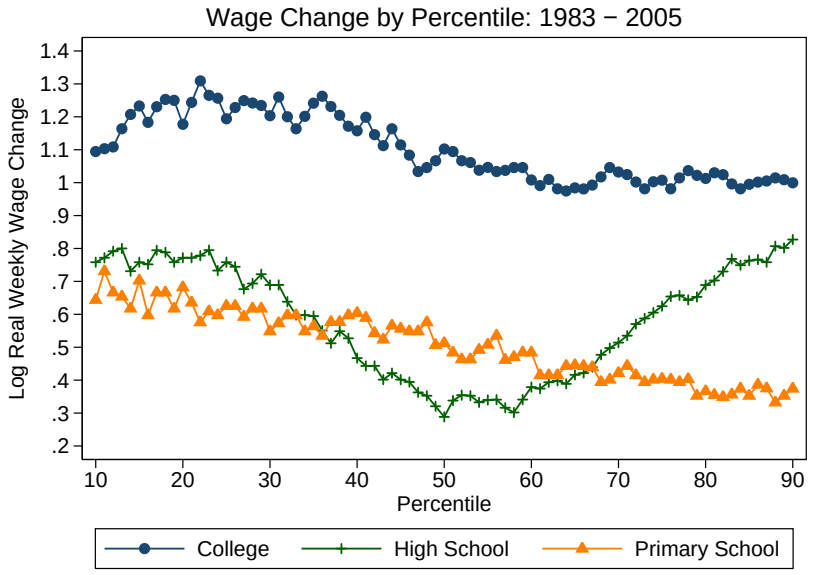

Figure 2: Inequality Between and Within Education Groups

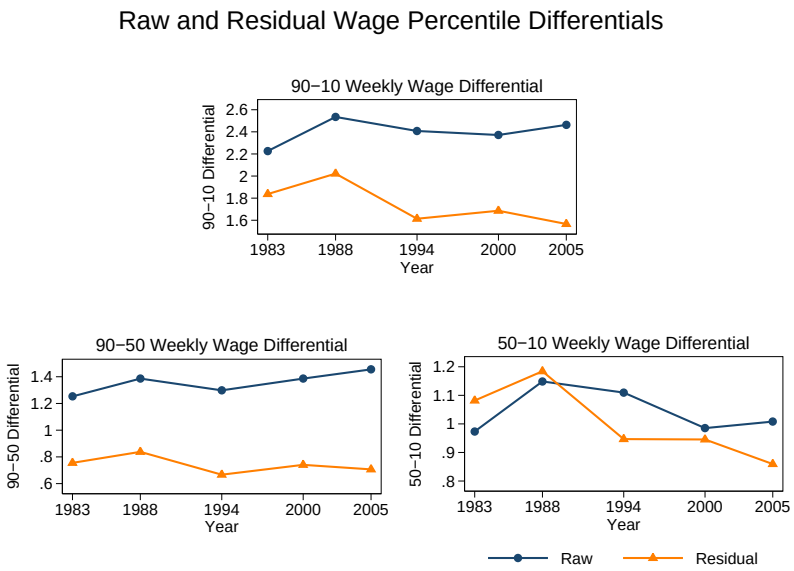

Figure 3: Raw and Residual Wage Inequality

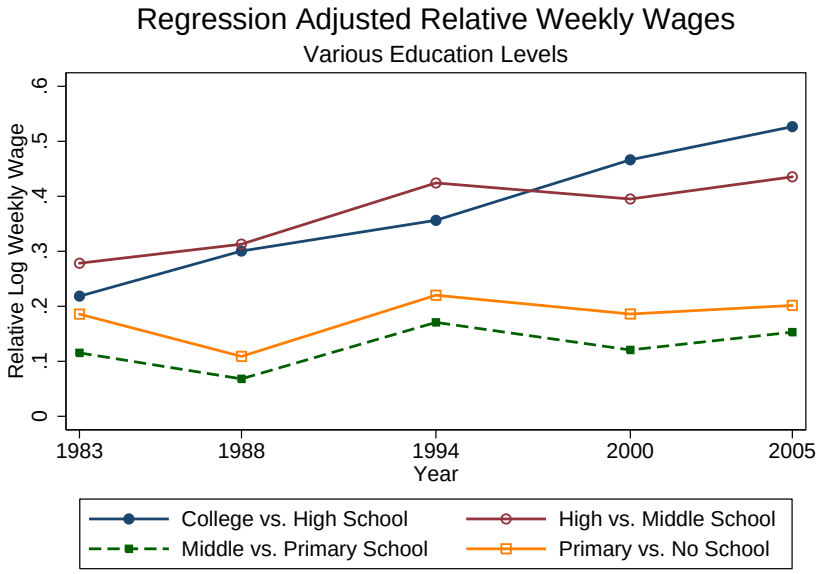

Figure 4: Returns to Education

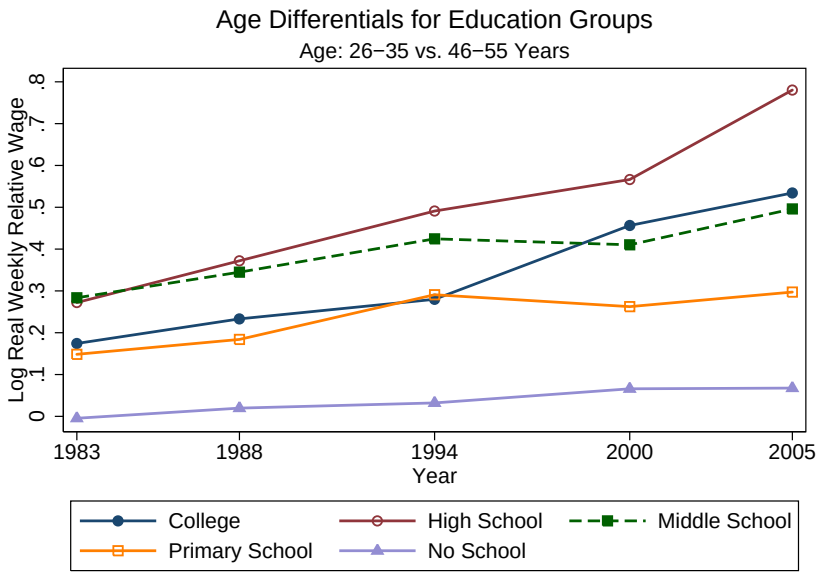

Figure 5: Returns to Labor Market Experience as Measured by Age

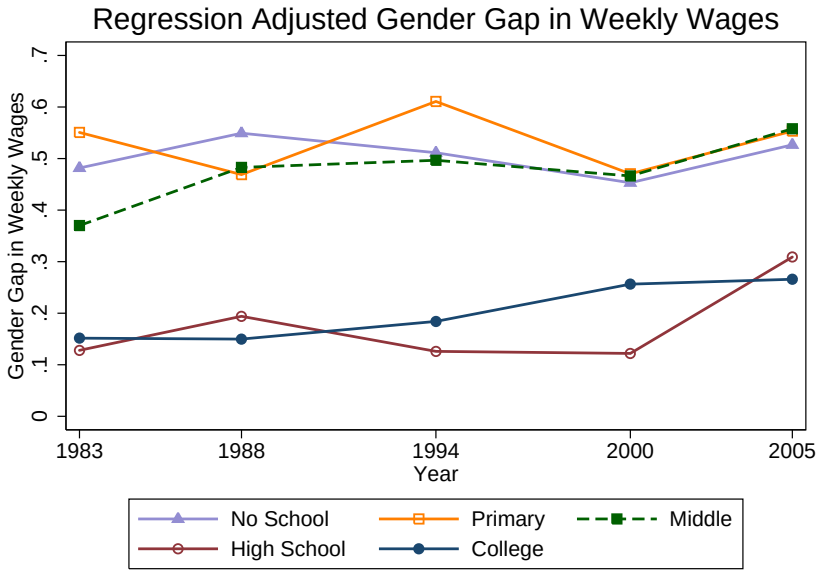

Figure 6: Gender Wage Gap

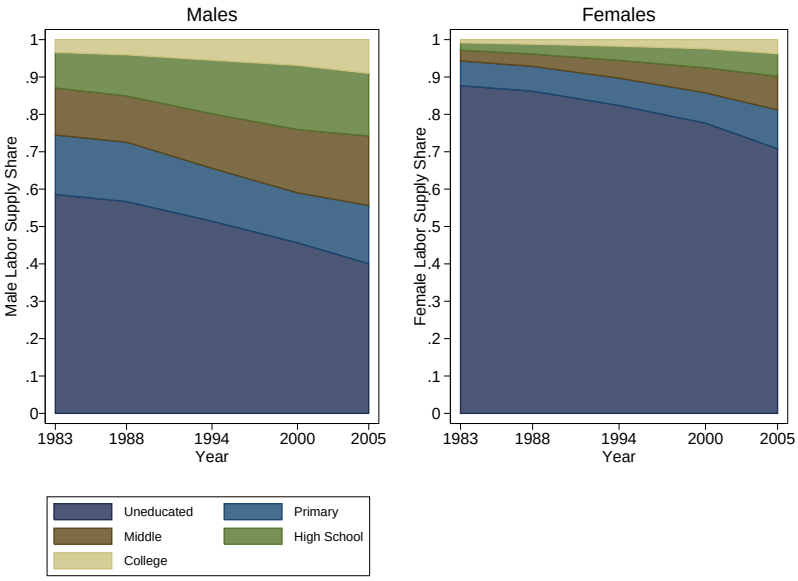

Figure 7: Labor Supply

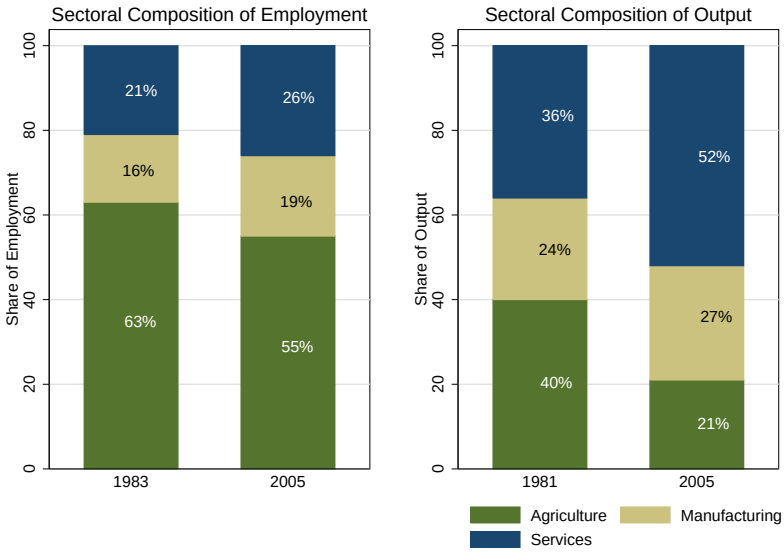

Figure 8: Sectoral Composition of Employment and Output

References

[1] Acharya, Rajat (2006), "Trade Liberalization, Poverty and Income Inequality in India", INRM Policy Brief No. 10.

[2] Attanasio, Orazio, Pinelopi Goldberg and Nina Pavcnik (2004), "Trade Reforms and Wage Inequality in Colombia", *The Journal of Development Economics*, Vol. 74, pp. 331-366.

[3] Autor, David H., Lawrence F. Katz and Melissa S. Kearney (2008), "Trends in U.S. Wage Inequality: Revising the Revisionists", *The Review of Economics and Statistics*, Vol. 90, No. 2, pp. 300-323.

[4] Autor, David H., Lawrence F. Katz and Alan B. Krueger (1998), "Computing Inequality: Have Computers Changed the Labor Market?", *The Quarterly Journal of Economics*, Vol. 113, No. 4, pp. 1169-1213.

[5] Banga, Rashmi (2005), "Liberalisation and Wage Inequality in India", Indian Council for Research on International Economic Relations Working Paper No. 156.

[6] Bargain, Olivier, Sumon K. Bhaumik, Manisha Chakraborty and Zhong Zhao (2007), "Earnings Differences Between Chinese and Indian Wage Earners, 1987-2004: Trends and Impact of Education", IZA Discussion Paper No. 3284.

[7] Behrman, Jere R. (1999), "Labor Markets in Developing Countries", in *Handbook of Labor Economics*, Vol. 3 eds. O. Ashenfelter and D. Card.

[8] Berman, Eli, John Bound and Stephen Machin (1998), "Implications of Skill-Biased Technological Change: International Evidence", *Quarterly Journal of Economics*, Vol. 113, No. 4, pp. 1245-1279.

[9] Berman, Eli and Stephen Machin (2000), "Skill Biased Technology Transfer Around the World", *Oxford Review of Economic Policy*, Vol. 16, No. 3, pp. 12-22.

[10] Berman, Eli, Rohini Somanathan and Hong W. Tan (2006), "Is Skill-Biased Technological Change Here Yet? Evidence from Indian Manufacturing in the 1990s", *Annales d'Economie et de Statistique*, 79/80.

[11] Chamarbagwala, Rubiana (2006), "Economic Liberalization and Wage Inequality in India", *World Development*, Volume 34, No. 12.

[12] Chamarbagwala, Rubiana (forthcoming), "Economic Liberalization and Urban-Rural Inequality in India: A Quantile Regression Analysis", *Empirical Economics*.

[13] Chamarbagwala, Rubiana (2009), "Industrial De-Licensing, Trade Liberalisation, and Skill-Upgrading in India", Working Paper.

[14] Dutta, Puja V. (2005), "Accounting for Wage Inequality in India", PRUS Working Paper 29.

[15] Fields, Gary S. (2008), "Segmented labor market models in developing countries", retrieved February 24, 1010 from Cornell University, ILR School site: http://digitalcommons.ilr.cornell.edu/articles/162/.

[16] Frias, Judith A., David S. Kaplan and Eric A. Verhoogen (2009), "Exports and Wage Premia: Evidence from Mexican Employer-Employee Data", Working Paper.

[17] Goldberg, Pinelopi and Nina Pavcnik (2004), "Trade, Wages, and the Political Economy of Trade Protection: Evidence from the Colombian Trade Reforms", *The Journal of International Economics*, Vol. 66, pp. 75-105.

[18] Ge, Sequin and Dennis Tao Yang (2008), "Accounting for Rising Wages in China", Conference Working Paper.

[19] Grimalda, Gianluca and Marco Vivarelli (2004), "One of Many Kuznets Curves? Short and Long Run Effects of the Impact of Skill Biased Technological Change on Income Inequality", IZA Discussion Paper No. 1223.

[20] Juhn, Chinhui, Kevin M. Murphy and Brooks Pierce (1993), "Wage Inequality and the Rise in Returns to Skill", *The Journal of Political Economy*, Vol. 101, No. 3, pp. 410-442.

[21] Kang, Seoghoon and Dong-Pyo Hong (June 2002), "Technological Change and Demand for Skills in Developing Countries: An Empirical Investigation of the Republic of Koreas Case", *The Developing Economies*, XL-2, pp. 188-207.

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

[23] Kijima, Yoko (2006), "Why Did Wage Inequality Increase? Evidence from Urban India: 1983-99", *The Journal of Development Economics* Vol. 81, pp. 97-117.

[24] Kremer, Michael and Eric Maskin (1996), "Wage Inequality and Segregation by Skill", NBER Working Paper 5718.

[25] Krueger, Anne O. and Sajjid Chinoy (2002),"The Indian Economy in Global Context", in *Economic Policy Reforms and the Indian Economy* ed. Anne O. Krueger.

[26] Krusell, Per, Lee E. Ohanian, Jos Victor Rios-Rull, and Giovanni L. Violante (2000), "Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis", *Econometrica*, Vol. 68 No. 5, pp. 1029-1053.

[27] Kugler, Maurice and Eric A. Verhoogen (2009), "Plants and Imported Inputs: New Facts and an Interpretation", *American Economic Review Papers and Proceedings*, Vol. 99, No. 2, pp. 501-507.

[28] Kuznets, Simon (March 1955), "Economic Growth and Income Inequality", *The American Economic Review*, Vol. 45, No. 1, pp. 1-28.

[29] Machin, Stephen and John Van Reenen (2007), "Changes in Wage Inequality", Centre for Economic Performance Special Paper No. 18.

[30] Machin, Stephen and John Van Reenen (1998), "Technology and Changes in Skill Structure: Evidence from Seven OECD Countries", *The Quarterly Journal of Economics*, Vol. 113, No. 4, pp. 1215-1244

[31] Marjit, Sugata and Rajat Acharyya (2003), "International Trade, Wage Inequality and the Developing Economy: A General Equilibrium Approach", Heidelberg: Physica/ Springer Verlag.

[32] Mazumdar, Joy and Myriam Quispe-Agnoli (2002), "Trade and the Skill Premium in Developing Countries: The Role of Intermediate Goods and Some Evidence from Peru", Federal Reserve Bank of Atlanta Working Paper 2002-11.

[33] Mazumdar, Joy and Myriam Quispe-Agnoli (2004), "Can Capital Skill Complementarity Explain the Rising Skill Premium in Developing Countries: Evidence from Peru", Federal Reserve Bank of Atlanta Working Paper 2004-11.

[34] Mishra, Prachi and Utsav Kumar (January 2005), "Trade Liberalization and Wage Inequality: Evidence from India", IMF Working Paper WP/05/20.

[35] Panagariya, Arvind (2008), *India The Emerging Giant*.

[36] Pavcnik, Nina (January 2002), "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants", *The Review of Economic Studies*, Vol. 69, pp. 245-276.

[37] Pavcnik, Nina (2003), "What Explains Skill Upgrading in Less Developed Countries?", *The Journal of Development Economics*, Vol. 71, pp. 311-328.

[38] Pavcnik, Nina, Andreas Blom, Pinelopi Goldberg and Norbert Schady (2004), "Trade Policy and Industry Wage Structure: Evidence from Brazil", *World Bank Economic Review*, Vol. 18, No. 3, pp. 319-344.

[39] Pradhan, Basanta K. (November 2002), "Role of Education in Wage Inequality Change in India: 1988-97", *Globalization and Poverty Reduction*.

[40] Reilly, Barry and Dutta, Puja V. (2005), "The Gender Pay Gap and Trade Liberalisation: Evidence for India", PRUS Working Paper 32.

[41] Robbins, Donald J. (October 1996), "HOS Hits Facts: Facts Win; Evidence on Trade and Wages in the Developing World", *Harvard Institute for International Development*, Development Discussion Paper No. 557.

[42] Srinivasan, T.N. (2000), *Eight Lectures on India's Economic Reforms*.

[43] Tan, Hong W. (October 2000), "Technological Change and Skills Demand: Panel Evidence from Malaysian Manufacturing", The World Bank Institute Working Paper.

[44] Taubman, Paul and Michael L. Watcher (1986), "Segmented Labor Markets", in *Handbook of Labor Economics*, Vol. 2, ed. O Ashenfelter and R. Layard.

[45] Tchipev, Anton (2006), "Technological Change and Outsourcing: Competing or Complementary Explanations for the Rising Demand for Skills During the 1980?" Quaderno N. 06-09.

[46] Topalova, Petia (2004), "Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty and Inequality from India", IMF Working Paper

[47] Topalova, Petia (2007), "Trade Liberalization, Poverty and Inequality: Evidence from Indian Districts", in *Globalization and Poverty* ed. Ann E. Harrison, pp. 291-336.

[48] Verhoogen, Eric A. (2008), "Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector", *The Quarterly Journal of Economics*, Vol. 123, No. 2, pp. 489-530.

APPENDIX A

A India Until 1991, The Crisis, and the Reforms of 1990s

Here, I give a brief overview of the structural reforms that have been implemented in India since the early 1990s.

In the mid 1980s, the fiscal and monetary policies in India became substantially more expansionary than previous policies. Such increased government expenditure proved unsustainable and the government had to borrow from domestic and foreign sources to finance its investment as well as current expenditure. The Gulf war caused oil prices to spike and workers' remittances to plummet, further worsening the situation. In 1990-91 the central government's fiscal deficit stood at 10.4% of GDP (Panagariya (2008)), inflation rose to 13.5 percent (Krueger and Chinoy (2002)) and in mid-1991 foreign exchange reserves were only enough to finance two weeks of imports despite an IMF loan of $1.8 billion in January 1991 and sharp cuts in imports.

Until 1991, the economy had been inward oriented. As of 1991, all imports either required licenses or were prohibited, despite some liberalization in the 1980s. All bulk items like cereals, petroleum, metals, and fertilizers, were 'canalized', i.e., they could be imported only by the government. Tariffs on imports were extremely high; the highest rate was 355% (Krueger and Chinoy (2002)), the simple average was 113% (Panagariya (2008)), and the import weighted average was 87% (Panagariya (2008)). Exports from India were also subject to several restrictions like prohibition, licensing, quantity ceilings, canalization, and pre-specified terms and conditions. Foreign direct investment (FDI) was severely restricted, allowing entry only into specific priority areas or when it provided technology transfer. There was an upper limit of 40 percent (Krueger and Chinoy (2002)) foreign equity in companies unless they were high-tech or export oriented. Companies receiving FDI also had to increase the domestic content of their output.

At this time there was a change in governments and a long term stabilization process was initiated, unlike the previous short term measures. Besides the usual stabilization measures, several unprecedented economic reforms were carried out that were aimed at changing the underlying structure of the economy that had hitherto not proved conducive to growth. The fiscal deficit was brought down to 5.7% of GDP in 1992-93.

In the first two years of reforms that began in July 1991, several measures were

implemented. The rupee was devalued 19% in real terms (Krueger and Chinoy (2002)). A market exchange rate was established in 2002 and by 2003 the official exchange rate was unified with it. Later, the rupee was made officially convertible on the current account. More recently, many capital account transactions have also been freed up. Licensing was abolished for most imports except consumer goods (license requirements on these were removed a decade later). Tariffs rates were slashed so that by 1995 the peak rate was 50% (Krueger and Chinoy (2002)). At the turn of the century, the import weighted average tariff rate stood at 30.2%. By 2004, the highest tariff rate on industrial goods was 20%, although there were some exceptions (Panagariya (2008)). These tariff reductions applied only to non-agricultural goods. In March 1992, the number of export items subject to control was brought down from 439 to 296, only 16 of which remained prohibited. FDI was also liberalized. The approval process was simplified and the percentage shares of domestic firms that could be owned by foreigners were increased. In May 2001, 100% foreign ownership of firms was permitted in several industries.

The industrial policy of the Indian government until early 1980s had been extremely interventionist. While heavy industry was a state monopoly, other industries either required licenses (that regulated scale, technology, and location of projects, and the outputs and inputs of plants) or were reserved for the small-scale sector. Panagariya (2002) mentions a 1980s cartoon strip in which the industry minister tells his staff, "We shouldn't encourage big industry - that is our policy, I know. But I say we shouldn't encourage small industries either. If we do, they are bound to become big." Public sector enterprises had become specimens of wasteful and inefficient activity and "acted as a brake on private sector development". (Srinivasan (2000)). However, the latter half of 1980s saw considerable liberalization of industrial policy. The licensing system was abolished and the business environment was significantly deregulated.

The financial sector also witnessed changes. In the late 1980s, public sector banks dominated commercial banking and the financial sector. National banks accounted for 92% of total deposits. Interest rates were controlled and substantial parts of credit had to be directed to priority sectors. Beginning in 1992, interest rates were gradually freed and directed credit was reduced. Competition in the banking industry was encouraged in various ways and more foreign and private banks were allowed to operate. Agriculture was largely left out of the reform process, mainly because of political economy constraints.

APPENDIX B

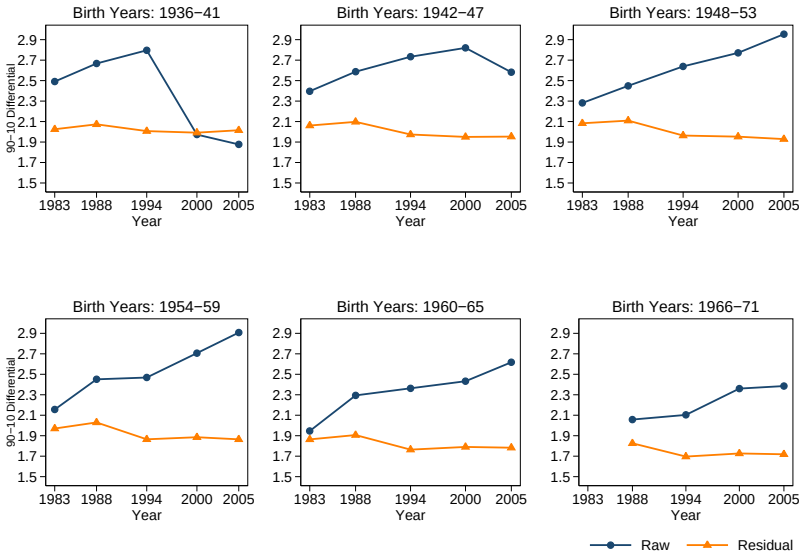

Figure 9: 90-10 Raw and Residual Wage Differentials for Six-Year Birth Cohorts

APPENDIX C

Results with the constructed Potential Experience Measure

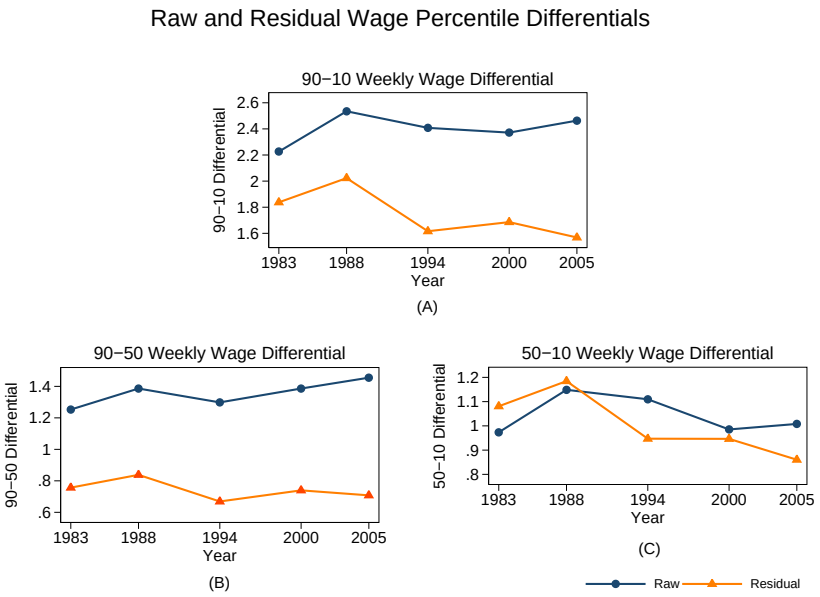

Figure 10: Raw and Residual Wage Inequality

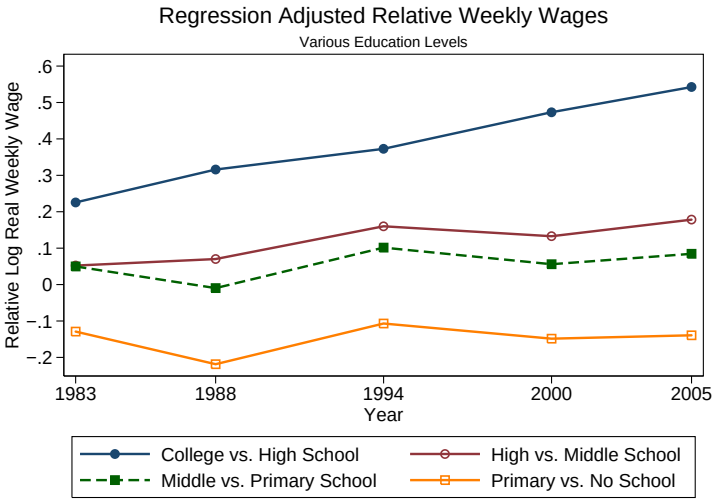

Figure 11: Returns to Education

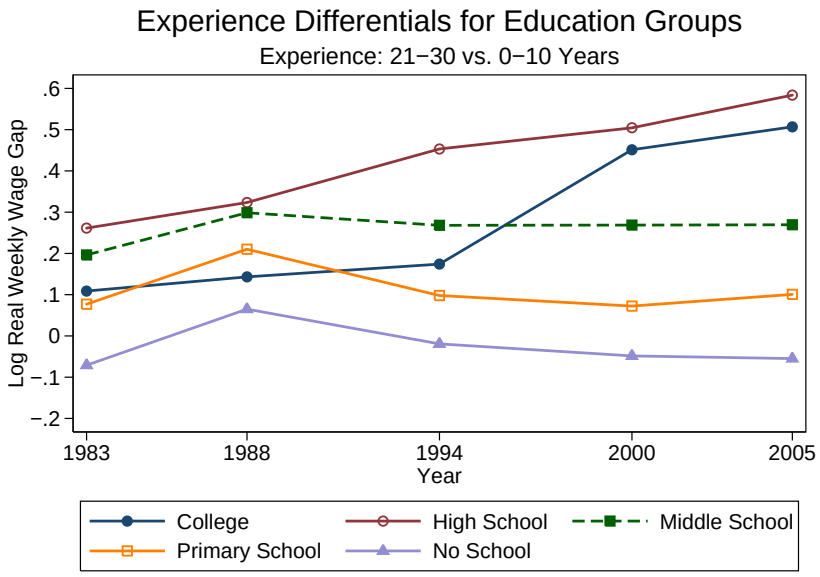

Figure 12: Returns to Experience

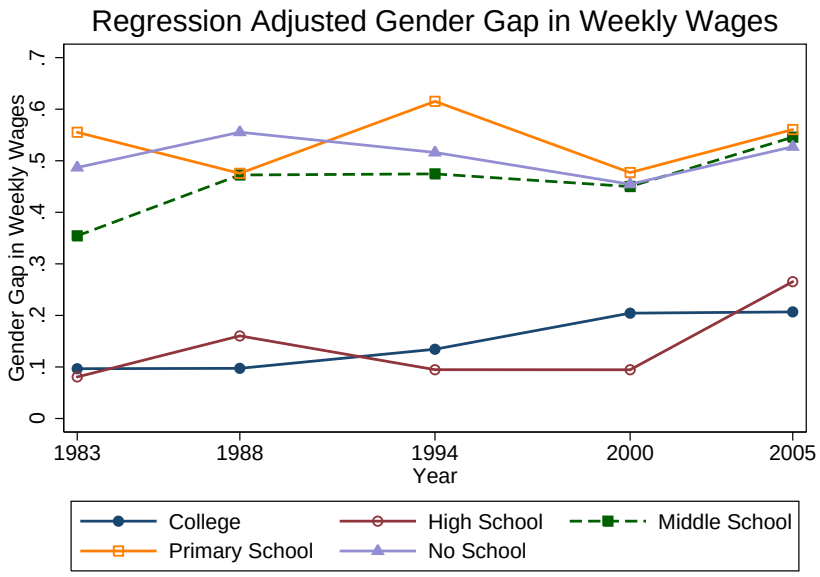

Figure 13: Gender Wage Gap