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Determinants of Wage Inequality in Developing Countries: Evidence from Manufacturing Industries

Priyanga Dunusinghe[1)]

Abstract:

With the anticipation of higher economic growth and a fair distribution of income, many developing countries have embarked on trade and investment policy reforms since around the early 1980s. On the contrary, majority of them have experienced a rapid rise in income (wage) inequality. With the intention of contributing to the on-going debate on the distributional consequences of globalization, triggered out by rising inequality, we examined the determinants of wage inequality in the manufacturing sector for a sample of developing countries during 1976-2002. By employing random-effects panel regression technique, we found that trade, technology, and relative labour supply are some of the key determinants of skilled-unskilled wage differential and a substantial portion of the mean difference of the wage differential between low- and middle-income countries could also be explained by those factors. Our results show that the promotion of education and training is one of the indispensable tools in countering the growing skilled-unskilled wage gap, especially in low-income countries.

Key words: Wage inequality; Panel data analysis; Developing countries
JEL Classification: F16; J31; L60

1 . Introduction

Since the early 1980s, the majority of developing countries are characterized, on the one hand, with an unprecedented level of economic integration and, on the other hand, with growing income (wage) inequality. Consequently, the debate on distributional consequences of globalization, right now at the forefront of academic and public policy circles, has been heated up. On the academic ground, considerable efforts have been made to explore, both theoretically and empirically, the patterns of wage inequality, its causes, and implications on broader inequality dimensions. Nevertheless, there is a limited agreement on the causes of wage inequality especially in

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the developing world.

There are only few cross-country studies in this area, compared to the great volume of country-case studies in the developing world[2]. Moreover, country-case studies have mostly been confined to few Latin American and Asian countries. Due to this limited coverage, it is quite difficult to generalize the existing findings across countries in different regions and of different level of economic development. Using internationally comparable data on manufacturing industries, published by the United Nations Industrial Development Organization (UNIDO), this study attempts to examine the determinants of wage inequality in a sample of developing countries consisting both low- (LICs) and middle-income countries (MICs). Additionally, the overall difference of skilled-unskilled wage gap between the two-country groups is decomposed into its contributing factors. Our sample contains data for 26 countries, representing Latin America and Asia for the period of 1976-2002. The number of sampling countries and the study period are primarily determined by the availability data[3]. We draw data for 28 manufacturing industries classified by the International Standard Industry Classification (ISIC) Ver. 2[4].

The rest of this paper is organized as follows. Section 2 briefly discusses the trends in skilled-unskilled wage ratio in LICs and MICs. Section 3 reviews the related literature while section 4 deals with the analytical framework and discusses the data and the construction of various data series. Section 5 reports regression results followed by a discussion, while section 6 makes some concluding remarks.

2. Trends in Skilled-Unskilled Wage differentials in Low- and Middle-Income Countries

Out of the 26 sampling countries, 14 are LICs[5]. As shown in Figure 1, the skilled-unskilled wage ratio in LICs has been higher than the MICs throughout the study period while the skilled-unskilled ratio has grown up in both country-groups. The rise in wage ratio in LICs has been rapid during 1980-1995, while in the mid 1990s they experienced a decline in the wage ratio.

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2) The lack of internationally comparable database on wages has been a major barrier for cross-country studies (Behraman, *et al*, 2007). The existing literature has used data sources such as household surveys of each member countries (Behrman *et al*, 2007), ILO October Inquiry data (Freeman and Oostendrop, 2000), and Industrial data (Avalos and Savvides, 2006) published by United National Industrial Development Organization (UNIDO).

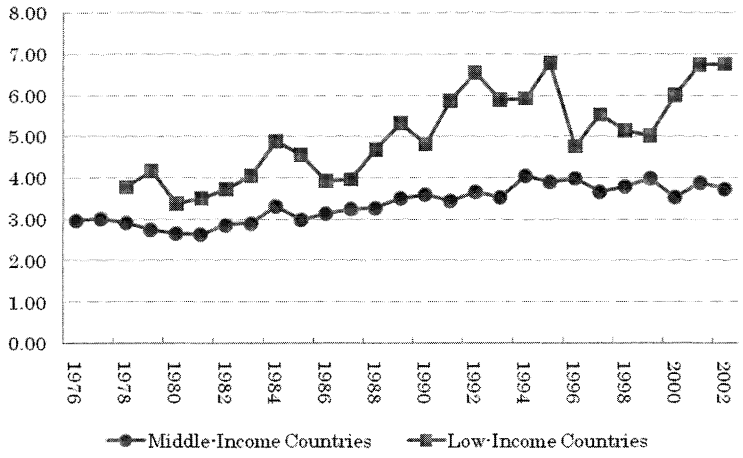
3) Since 2003, many of our sampling countries reported the data in ISIC ver. 3. As a result, our study period is confined to 1976-2002, since concordance between ISIC ver. 2 and 3 at 3-digit level is not possible.

4) See Appendix A for a list of manufacturing industries

5) Using the World Bank country classification system, the sample is divided into two set of countries, low-income and middle-income country-group. Low income countries are the ones whose Per Capita Gross National Income (PCGNI) in 2008 is lowers than the US $ 3,856 (low income countries+lower-middle-income countries) and countries whose PCGNI is above that level of income (upper middle-income countries+higher-income countries) is classified as middle-income countries.

However, it again picked up at the end of the 1990s probably due to the globalization process. In contrast, the rise in skilled-unskilled ratio has been moderately gradual in MICs. In MICs the ratio declined in the early 1980s, since then it increased gradually in subsequent years. One of the interesting facts is that the movements in skilled-unskilled ratio in both country-groups show similar patterns until the early 1990s and since then the pattern is disrupted probably due to the differential effects of globalization process in two-country groups. We will look into those factors in our regression analysis in detail.

Figure 1: Trends in Skilled-Unskilled Wage Inequality[a]



Note: (a) skilled-unskilled wage ratio is the average wage of top 10% of industries to the bottom 10% of industries.
Source: Author's calculation base on UNIDO data.

3. Literature Survey

The determinants of wage inequality could broadly be divided into two groups, namely demand- and supply-side determinants. However, this brief literature survey primarily focuses on demand-side determinants though we control our regression for some supply-side determinants[6].

The Stolper-Samuelson (SS) theorem is one of the traditional theoretical pieces that envisage the direction of the movement of relative price (wages) once a country liberalizes its trade regime. The SS theorem predicts that trade liberalization in a labour-abundant country leads to decline

6) In cross-country studies, education and female labour force participation are often used as supply-side determinants. However, in the empirical analysis we control the changes in the relative labour supply by introducing only the female labour force participation since annual data on education level is unavailable at cross-country level.

in relative prices (wages). Accordingly developing countries may experience decline in relative wages since it is often assumed that developing countries are labour-abundant. Some early empirical studies on trade-wage relationship had found evidence to support the Stolper-Samuelson (SS) theorem (Wood, 1997). On the contrary, many recent studies have found evidence that trade reforms in many developing countries has led to rise in relative wages (Chambarbagwala, 2006; Goldberg and Pavcnik, 2007; Robbins, 2003; Topalova, 2005). According to these studies, an increase in skill-premium, subsequent to the trade reforms, has been one of the main causes of rising wage inequality. Davis (1996) provided a theoretical framework with which the positive relationship between trade policy reforms and skilled-unskilled wage differentials could be explained. He argued that the reference set against which one measures the relative factor abundance should not be the global economy, instead, factor abundance matters only relative to a smaller set of countries with similar endowment proportions[7]. In this case, some countries that are unskilled-labour-abundant in global sense may actually be skilled-labour abundant. Author argues that trade liberalization in those countries may lead to increase wages of skilled-workers.

Since the SS theorem happened to be less convincing for explaining the growing wage inequality, a number of alternative explanations have been introduced in recent years. Importation of technology, FDI-driven outsourcing activities, and quality improvements of exporting firms are some of those alternative explanations (Goldberg and Pavcnik, 2007; Hanson and Feenstra, 1996; Kijima, 2006; Verhoogen, 2008).

It is argued that trade liberalization enables developing countries to import new-technology-augmented machinery and equipments. As a result, demand for skilled-labour increases since technological developments in industrialized countries is skilled-biased in nature (Acemoglu, 2003; Mayer, 2000). Increase in demand for skilled-workers push the relative wages up since the supply of skilled-workers grows at a slower space in developing countries.

Foreign direct investments that promote of both trade and technological transfer could also lead to increase in relative wages in recipient countries (Feenstra and Hanson, 1997). FDI-driven outsourcing activities increase the demand for skilled-labour since the production activities shifted to developing countries would be characterized as unskilled-labor-intensive from a developed country's perspective, however, they appear skilled-labor-intensive when compared with existing domestic production activities from the developing country's point of view. This in turn leads to an increase in the skill premium in both places.

In recent years, quality improvement activities– productivity improvements and/or product up-grading – of more efficient and bigger firms, mostly engage in exporting activities, has been

7) As in the SS theorem, many developing countries are labour-abundant if the reference set is the global economy.

identified as one of the driving forces of skilled-labour demand and for that matter the skill-premium (Helpman et al, 2008; Melitz, 2003, Tybout, 2003, Verhoogen, 2008). Quality improvements depend on the fraction of skilled-workers employed in a firm. Firms, especially engage in international trading activities, pay higher wages for attracting high-quality skilled-workers into their firms, thereby leading to rise in within-industry wage inequality. Verhoogen (2008) found that quality improvement initiatives of exporting firms following the currency devaluation in Mexico in 1994 led to the rise in relative wages. Similarly (Kandilov, 2009) found that relative wages in medium-size exporting firms that received government subsidy for export promotion increased during the subsequent years.

The above reported evidence is mainly from country-case studies. However, findings of cross-country studies also show somewhat similar evidence (Avalos and Savvides, 2006; Behrman *et al*, 2007; Wood, 1994). Using household surveys for 18 Latin American countries, Behrman, *et al* (2007) examined whether economic reforms affect wage differentials[8]. One of the interesting findings of this study is that though there is a positive correlation between each policy reform indicator and wage differentials, this association gradually fads away over the time. In contrast, Avalos and Savvides (2006), using the manufacturing industry data published by the UNIDO, examined whether some of the hypotheses established by country-case studies are held for a cross-section of countries comprising Latin American and East Asian economies. In line with the findings of country-case studies, they found that trade openness, technological transfer, FDI, and relative labour supply are the main determinants of wage inequality.

Although Avalos and Savvides (2006) and Behrman *et al*, 2007 made a significant contribution in exploring the determinants of wage inequality at cross-country level, there are some limitations in their studies. First, when exploring the determinants of wage inequality, none of the study made an attempt to examine them from the dimension of the level of income of sampling countries[9]. Second, Avalos and Savvides (2006) conducted their regression analysis with level data. The use of data in their levels for the regression analysis may not be suitable given the data have a substantial time length, 1963-98, and most variables have upward trends over the time. Finally, none of the studies examined the relevance of the quality improvement hypothesis as a possible explanation for rising wage inequality.

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8) Economic reforms include policy reforms such as trade, financial, tax, and privatization. Hence, this study examined the movements of wage differentials in a broader policy reform environment. Though this approach is comprehensive, it demands better data on wage and policy reforms that in most cases lack in many developing countries.

9) A vast available literature on this area argues that the determinants of wage inequality may differ across countries, even within the developing world, on the basis of the level of income (Behar, 2007: Goldberg and Pavcnik, 2007, Robbins, 2003).

4. Analytical Framework

On the basis of the literature just reviewed, we specify following regression model that includes both demand- and supply-side determinants of wage inequality are introduced.

$$\omega_{it}=\beta_0+\beta_1 EI_{it}+\beta_2 TO_{it}+\beta_3 FDI_{it}+\beta_4 TAIM_{it}+\beta_5 \mathrm{INV}_{it}+\beta_6 FLP_{it}+u_{it} \quad (1)$$

In eq. (1), ω is the skilled-unskilled wage differential. While export (or total trade) intensity (EI or TTI), trade openness (TO), technology-augmented imports of machinery and equipments (TAIM), foreign direct investment (FDI), and physical capital accumulation (INV) are proxy variables for relative productivity differentials while female labour force participation (FLP) is the proxy for the relative labour supply. While u represents the independently and identically distributed error term, small i and t denote country and time.

Recent theoretical models argue that exporting (also importing) firms pay higher relative wages than the firms that serve only to domestic markets (Helpman *et al*, 2008; Melitz, 2003, Tybout, 2003, Verhoogen, 2008). According to these models, firms that engage in exporting activities require to undertake continuous quality improvements activities – *productivity improvements and/or product quality upgrading*[10]. Additionally, skilled-enhanced-trade (SET) hypothesis, proposed by Robbins (1995) argues that exposure to international trade encourage firms to engage in skill enhancement for improving productivity levels and be internationally competitive. We attempt to test these hypotheses through the effect of export and trade exposure. To that effect, we introduce the export intensity (EI) and total trade intensity (TTI) variables into our model.

It is now well-documented that trade liberalization leads to higher productivity levels in the economy in general and in exporting sector in particular (Dornbusch, 1992). However, the effects of these productivity gains on relative wages depend on the relative abundance of factors in the economy. Provided that the unskilled labour is abundant in developing countries, the Stolper-Samuelson theorem predicts that trade liberalization could lower the relative wages (Robbins, 2003). That is abundant factor is rewarded during the post-liberalization. Here, we introduce the level of trade openness (TO) variable to capture the effect of trade liberalization on wage differential.

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10) The level of quality improvements exclusively depend on the fraction of skilled-to-unskilled workforce in a firm. Hence, exporting firms employ more productive skilled workers in larger proportion than the firms that only serve to domestic markets. To employ more productive skilled workers firms have to pay higher wages relative to averagely available in the market.

One of the leading theoretical pieces for countering the trade-based explanations on rising skill-premium is the Skill-Biased Technological Change (SBTC) hypothesis (Acemuglu, 2002, 2003). It is argued that developing countries could access to the technological innovation in developed countries through importing new technology-agumented machinery and equipments. Ekholm and Midelfart (2005), Behrman, *et al* (2000), and Cragg and Epelbaum (1996) further explore the role of imports for technological transfer and/or diffusion. To capture the technological diffusion and its effect on skilled-unskilled wage differentials, we include R&D augmented technology (machinery) imports (TAIM) in to our regression.

Trade models based on intermediate goods trade and outsourcing (or production fragmentation) have become quite prominent in recent years in providing a possible explanation to the increase in relative wages both in developed and developing countries. Hanson and Feenstra (1997) argued that FDI flows directed at outsourcing activities led to an increase in relative wages in recipient countries[11]. To capture the FDI-driven outsourcing activities on skilled-unskilled wage differentials in recipient countries we introduce relative size of the FDI inflows into our regression model[12].

Physical capital accumulation has been identified as one of the causes of rise in skilled-unskilled wage differentials since capital goods are complementary with skilled-workers[13]. To capture this effect, we introduce gross domestic investment into our regression model. Since there is no relative labour supply data for our sampling countries, we condition the relative labour supply by introducing female labour force participation rate (FLP) into our model. It is expected that there is a negative relationship between relative wage and FLP[14].

Data and Data Sources

Following Avalos and Savvides (2006), we construct a measure for the skilled-unskilled wage differential (ω) using UNIDO database for manufacturing industries. In construction of the measure, for each sampling country and year, we sort the real wage per worker of all industries in ascending order and then take the average wage of the industries that represent the top 10% and of the bottom 10% of industries separately[15]. Here, it is assumed that the average wage of

11) It is noted that that products shifted, through FDI activities, to developing countries would be characterized as unskilled-labor-intensive from a developed country's perspective, they appear skilled-labor-intensive when compared with existing domestic production activities from the developing country's point of view.

12) It should be noted that all the FDI flows may not be for outsourcing activities. However, it is difficult to obtain outsourced-oriented FDI data.

13) See Krisell *at al* (2000).

14) Following Avalos and Savvides (2006), this paper also uses the FLP as a proxy for the relative labour supply. An increase in female labour force participation in the labour market leads to increase the average skill-level in an economy due to two reasons. First, Topel (1997) argues that majority of new female entrants are educated ones from young cohorts. Second, if it is assumed that female entering to the labour find jobs in the unskilled sectors, men would gradually move into skilled sectors, thereby increasing the relative labour supply. Hence, an increase in female labour force participation rate push the average skill level up, thereby increasing the relative labour supply.

the top 10% industries represents the average wage of 'skilled-workers' whereas average wage of the bottom 10% industries represents the average wage of 'unskilled-workers'. The ratio of average wage of top 10% to that of the bottom 10% is our measure of 'skilled-unskilled' wage differential.

To construct the export (total trade) intensity (EI and TTI), using UN Comtrade database, we first take the share of export (total trade) to total production of top 10% of industries and that of the bottom 10% of industries separately[16]. Second, we take the ratio of these two measures to represent the relative export (trade) exposure. To construct the technology-augmented imports of machinery and equipments (ATIM), we proceeded as follows. First, we calculated the relative share of machinery and equipment imports of each country from five industrialized countries (the USA, UK, Japan, France, and Germany). Then we multiply this relative share by the relative share of research and development (R&D) expenditure in manufacturing sector of each industrialized country (R&D to total manufacturing production). By doing so, we obtain the R&D-weighted technology imports (machinery and equipments). We obtain trade data from source OECD database of Organization for Economic Cooperation and Development (OECD) and R&D data from the OECD's Analytical Business Enterprise Research and Development Expenditure in Industry (ANBERD) database. Trade openness (TO) (total trade/GDP), females labour force participation rate (FLP) (female labour force / total labour force), gross domestic investment ratio (gross fixed capital formation / GDP), and foreign direct investment (FDI) (net foreign direct investments / GDP) are extracted from the World Development Indicators (WDI) online database. It should be noted here that individual variables enter into the regression models in the form of annual growth rates.

5 . Estimation

Summary statistics of variables used in the regression analysis are reported, separately for LICs and MICs countries, in table 1. The 'skilled-unskilled' wage ratio grew at an average annual rate of 4.6 % in LICs, whereas in MICs it grew at an average annual rate of 2.3 %. As can be inferred from the growth of the level of trade openness, during the study period, MICs have further liberalized their trade regimes quite faster than their counterparts. Relatively weaker growth of net FDI inflows in MICs implies that FDI outflows from those countries have been somewhat stronger, reflecting the fact that some of their production activities shifted, amidst rising labour cost, to LICs. As a result, at least partly, average growth of net FDI inflows in LICs has been quite higher. The growth rates of technological imports states that LICs heavily

15) In our data set, we exploit data of 28 manufacturing industries for each sampling country for a given year.
16) The classification of the top 10% and the bottom 10% of industries are based on the level of wage per worker.

depend on imported technology compared to MICs. For instance, technology imports in LICs grew at an average annual rate of 8.8% compared to the 5.1% growth reported in MICs. The growth of human-capital formation, captured by the growth of female labour force participation, has been higher in MICs than LICs. Reflecting the complementarity between the formation of human capital and physical capital, the growth of gross fixed capital formation has been faster in MICs than the LICs.

The correlation coefficient between the growth of 'skilled-unskilled' wage ratio and that of the export intensity (also total trade intensity) is positive (see table 2). It implies that the higher the level of exporting activities industries engage in, the faster the 'skilled-unskilled' wage ratio grows. Similarly, the correlation coefficients of the growth of 'skilled-unskilled' wage ratio with the growth of technology imports and trade openness are also positive. Hence, there is some preliminary evidence that trade and technology have been behind the wage inequality. The negative correlation coefficient of the growth of female labour force participation rate is consistent, since growth of relative labour supply suppresses the increase of 'skilled-unskilled' wage ratio that is commonly called as the 'wage compression effect' of relative labour supply[17]. Interestingly, the sign of these relationships are consistent with the existing findings of country-case studies. On the contrary to the common presumption, correlation coefficients of the growth of 'skilled-unskilled' wage ratio with the FDI and grows domestic investment are negative implying that both FDI and investment are complementarity to unskilled-labour. However, it is highly suspicious that these relationships are held in middle-income countries, though there is some possibility of holding them in low-income countries.

Eq. (1) is estimated using the random-effects panel regression technique and results are reported in table 3[18]. Our dependant variable is the annual growth of 'skilled-unskilled' wage ratio while each independent variable enters into regression models in the form of its annual growth rate. From model (1) through (9), 'skilled-unskilled' wage ratio is defined as the ratio of average wage per worker in top 10% of industries to the bottom 10% of industries while from model (7') through (9'), it is defined as the ratio of average wage per worker in top 20% of industries to the bottom 40% of industries[19].

Only the growth of export intensity (EI) enters into model (1) as an explanatory variable. The estimated coefficient of EI is positive [0.011 (s.e. 0.006)] and statistically significant at 10% level of significance (see table 3). In addition, this variable enters into model (2), (3), (6), and (7) along

17) The wage compression effects mean that an increase in relative labour supply puts pressure on narrowing down the relative wages.

18) The relevance of the random-effects model, in case of our dataset, is established through Hausman test (see table 3).

19) Industries are sorted by ascending order, for each year in individual sampling countries, on the basis of average wage per worker.

Table 1: Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Low-income countries					
Growth of 'skilled-unskilled' wage ratio	234	4.61%	35.73%	-74.51%	141.29%
Growth of export intensity ratio	234	23.58%	39.48%	-93.81%	195.66%
Growth of total trade intensity ratio	234	19.65%	5.12%	-93.16%	13.90%
Growth of trade openness ratio	234	1.87%	10.39%	-34.56%	71.78%
Growth of net foreign direct investment inflow ratio	206	6.64%	81.80%	-238.40%	429.50%
Growth technology-augmented import index	232	8.81%	31.77%	-47.21%	262.61%
Growth of female labour force participation rate	193	0.67%	5.82%	-30.11%	48.24%
Growth of gross domestic investment ratio	227	0.47%	9.89%	-39.82%	28.86%
Middle-income countries					
Growth of 'skilled-unskilled' wage ratio	284	2.27%	15.78%	-47.05%	104.23%
Growth of export intensity ratio	284	21.70%	16.20%	-95.11%	379.37%
Growth of total trade intensity ratio	284	13.33%	52.50%	-95.33%	151.04%
Growth of trade openness ratio	255	2.10%	11.39%	-40.54%	74.98%
Growth of net foreign direct investment inflow ratio	279	3.40%	84.10%	-476.80%	257.50%
Growth technology-augmented import index	280	5.11%	20.12%	-45.63%	128.94%
Growth of female labour force participation rate	242	1.28%	2.57%	-5.84%	13.11%
Growth of gross domestic investment ratio	273	0.55%	13.62%	-54.41%	74.98%

Table 2: Correlation Matrix

Variables	SUW	EI	TTI	TAIM	TO	FDI	FLP	INV
The 'skilled-unskilled' wage ratio (SUW)	1.000							
Export intensity ratio (EI)	0.086	1.000						
Total trade intensity ratio (TTI)	0.076	0.599	1.000					
Technology-augmented import index (TAIM)	0.136	0.023	-0.015	1.000				
Trade openness ratio (TO)	0.120	-0.040	-0.046	0.056	1.000			
Net foreign direct investment inflow ratio (FDI)	-0.129	-0.009	0.110	0.055	-0.034	1.000		
Female labour force participation rate (FLP)	-0.223	-0.011	-0.005	-0.042	-0.093	0.044	1.000	
Gross domestic investment ratio (INV)	-0.078	0.045	0.057	0.127	0.107	0.026	0.078	1.000

with some other explanatory variables. In all cases, its estimated coefficient is positive and statistically significant. To capture the combined effect of export and import intensity together, total trade intensity (TTI) is introduced into model (4), (5), (8), and (9)[20]. In all these cases as well, the estimated coefficient of TTI is positive and statistically highly significant. For instance, the estimated coefficient of TTI in model (9) is 0.046 (s.e. 0.018) and statistically significant at 1% level of significance. Interestingly, the magnitude of the estimated coefficient of TTI is bigger than the EI, reflecting the fact that the combined effect of export and import intensity is bigger on wage differential than the EI alone. Although we introduce interaction terms of both EI and TTI – interacting with middle-income country dummy (MICD) - to examine whether the effect of EI and TTI differ between MICs and LICs, none of the estimated coefficients of those interaction terms are significant at conventional level of significance in respective models. It means that exports pays higher relative wages to skilled-workers in both MICs as well as LICs.

The positive effect of EI on SUW ratio implies that the greater the level of exporting activities an industry engages in, the higher the demand it makes for skilled-workers, and the better the relative compensation its skilled-workers receive. As a result, skilled-unskilled wage differential widens more rapidly in export-oriented industries. Exporters in developing countries pay higher wages, especially for skilled-workers, since one of the main requirements to be successfully breaking into markets in developed countries and to be sustained is the production of quality products[21].

Our finding is largely consistent with both theoretical arguments (Helpman *et al*, 2008; Melitz, 2003, Tybout, 2003, Verhoogen, 2008) and with findings of previous empirical studies (Alvarez and Lopes, 2005; Bernard and Jensen, 1997; Kandilov, 2009; Martins and Opromolla, 2009; Meschi *et al*, (2009); Munch and Skaksen, 2008; Schank, Schnabel, and Wagner, 2007; Verhoogen, 2008). For instance, Meschi *et al*, (2009) found a positive and significant role of total trade and exports in increasing within-country income inequality in developing countries. In their study on manufacturing plants in Chile, Alvarez and Lopes (2005) found that exporting firms pay 21% higher on average wage, and 15% and 28% higher on production and non-production wage respectively[22].

The growth of trade openness (TO) enters into regression model (2) through (9). The estimated coefficient of TO is 0.263 (s.e. 0.113) and is statistically significant at 5 % level of significance in

20) Import intensity is also introduced as an explanatory variable into our regression models, nevertheless, none of the occasions it turn out be statistically significant at conventional level of significance.

21) As Verhoogen (2008) argues quality improvement – productivity improvement and/or product up-grading – exclusively depends the relative share of the skilled-workers in the total work force in a firm. Hence, demand for skilled-workers as well as skill-premium are increased with the expansion of exporting activities in an industry.

22) Schank, Schnabel and Wagner (2007) summarized the evidence of 21 empirical studies that found a positive export-wage-premium.

model (2) (see table 3). Similarly, it is positive and statistically significant either at 5 % or less than that in the rest of the models. The positive association between trade policy and 'skilled-unskilled' wage ratio implies that trade liberalization in developing countries, often assumed as labour-abundant countries, leads to increase in relative wages on the contrary to the prediction of well-known Stolper-Samuelson (SS) theorem in the Heckscher-Ohlin-Samuelson (HOS) model[23].

Although some early research had found some evidence to suggest that the SS theorem was in operation (Wood, 1994, 1997), there are now overwhelming evidence that trade liberalization in many countries led to increase in relative wages and income inequality (Goldberg and Pavcnik, 2007; Robbins, 1995, 2003)[24]. Robbins (1995), a study of seven countries in Latin America and East Asia, showed that in almost all cases, the relative skilled-unskilled wage ratio rose after the trade liberalization.

An interaction term (TO*MICD) is introduced into model 5, and also into model 7 through 9, to examine whether the effect of trade openness on wage differentials differs between LICs and MICs. The estimated coefficient of the interaction term affirms that, on the contrary to the most empirical evidence, the TO has a highly significant and negative association with skilled-unskilled wage ratio in MICs (see table 3). For instance the estimated coefficient of the interaction term in model 5 is -0.152 (s.e. 0.026) and is statistically significant at 1 % level of significance. This is quite an unexplainable result since the majority of studies in MICs had found a positive association between trade policy and inequality (Goldberg and Pavcnik, 2007; Robbins, 2003).

As far as author knows, the only evidence that supports our findings comes from Wood (1994) and Robertson (2001). Wood (1994) found some evidence that trade liberalization in East Asian four tigers – Hong Kong, Republic of Korea, Singapore, and Taiwan – led to decline in wage inequality. Similarly, Robertson (2001) found that wage inequality has declined in Mexico after it joined the North American Free Trade Agreement (NAFTA). He argues that before entering into NAFTA, Mexico is relatively abundant in skilled-labour as against the rest of the developing world, however, it became relatively unskilled-abundant country against the USA and Canada after joining the NAFTA. As a result Mexico experienced decline in relative wage of skilled-unskilled wage.

The growth of foreign direct investment (FDI) is introduced into model (2) through (9). In model (2), its estimated coefficient is -0.007 (s.e. 0.003) and is statistically significant at 5% level of significance. Similarly, the estimated coefficient of FDI is negative and statistically significant at 5% or less than that level of significance in the rest of the models. The negative

23) The SS theorem has often been cited by international organizations such as the World Bank and the International Monetary Fund (IMF) for encouraging developing countries to undertake trade reforms.
24) Robbins summarizes the arguments put forward by various researchers for the failure of the SS theorem.

association between the FDI and 'skilled-unskilled' wage ratio implies that FDI inflows into developing countries lead to more equitable distribution. This is a situation that an increase in wages of unskilled-worker due to FDI activities is higher than the skilled-workers[25]. It may be a plausible reasoning since FDI inflows into many developing countries, especially low-income countries, channel into labour-intensive sectors. A higher demand for unskilled-labour in those sectors might put heavier up-ward pressure on the wage of unskilled-labour than the skilled-labour. As a result, FDI could narrows down the skilled-unskilled wage differential. A somewhat similar result was found by Figini and Görg (2006) for a sample containing data for 100 countries over the period of 1980-2002. They found that there is a non-linear relationship between FDI stock and wage inequality. Although FDI stock tends to increase wage inequality at its lower level, subsequent increase in FDI stock leads to decline in wage differentials.

Since the negative association between FDI and wage inequality is rather-loosely fitted into empirical evidences of many previous country-case studies as well as theoretically unsound especially in the case of middle income countries, an interaction term (FDI*MICD) is introduced into model (5), and model (7) through (9) to examine whether the effect of FDI on wage inequality differ between LICs and MICs. Interestingly, other than in model (7), the estimated coefficient of the interaction term is positive and statistically significant. For instance, the estimated coefficient of the interaction term in model (9) is 0.012 (s.e. 0.006) and it is statistically significant at 5% level of significance. This result implies that the impact of FDI on the direction of wage differential differ between LICs and MICs. In short, FDI tends to increase the wage inequality in MICs whereas in LICs FDI narrows down the wage differential. The existing evidence of country-case studies on the effect of FDI on wages states that foreign firms and/or their affiliations pay higher wages than their domestic counterparts. For instance, Te Velde (2003) found that foreign-owned enterprises pay 8%, 22%, 17%, and 23% more in Cameroon, Ghana, Kenya, and Zambia respectively. Also, Ramstetter (1999) found that foreign-owned enterprises pay 27%, 20%, 9%, and 16% higher in Hong Kong, Malaysia, Singapore. Further, although both skilled and unskilled workers in foreign-owned firms are paid higher wages than their counterparts in local firms, wage difference of skilled-workers is much higher than the unskilled workers. Aitken, *et al* (1996) found that foreign-owned firms pay 29% and 22% more for skilled-workers in Venezuela and Mexico respectively while unskilled workers receive 22% and 3.3% more in respective countries. Similarly, Gopinach and Chen (2003) found that FDI inflows led to increase in skilled-unskilled wage ratio in developing countries.

Since the mid 1990s, technology-based explanation on wage inequality in developed countries has dominated the literature. The relevance of this piece of explanation in the context of

25) This statement is based on empirical evidence that foreign-owned firms (FOFs) pay higher than the local firms for both skilled- and unskilled-workers (Te Velde, 2003).

Table 3: Panel Data Analysis: Random-Effects Model

Dependant variable: Annual growth of 'skilled-unskilled' wage ratio[a][b]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)[d]	(7')	(8')	(9')
Constant	0.031***	0.026**	0.019	0.018	0.022*	0.038**	0.031**	0.028**	0.101	0.013***	0.013*	0.042
	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.015)	(0.014)	(0.014)	(0.128)	(0.007)	(0.007)	(0.062)
Export intensity (EI)	0.011*	0.011*	0.010*	–	–	0.011*	0.018*	–	–	0.069***		
	(0.006)	(0.006)	(0.006)	–	–	(0.006)	(0.010)	–	–	(0.016)		
EI*MICD[c]	–	–	–	–	–	–	-0.006	–	–	-0.058		
	–	–	–	–	–	–	(0.042)	–	–	(0.117)		
Total trade intensity (TTI)	–	–	–	0.020*	0.037**	–	–	0.049***	0.046***		0.100***	0.097***
	–	–	–	(0.011)	(0.015)	–	–	(0.017)	(0.018)		(0.019)	(0.020)
TTI*MICD	–	–	–	–	-0.028	–	–	-0.041	-0.032		-0.100	-0.086
	–	–	–	–	(0.021)	–	–	(0.033)	(0.024)		(0.319)	(0.032)
Trade openness (TO)	–	0.263**	0.243**	0.242**	0.111***	0.261**	0.130***	0.130***	0.286***	0.301***	0.292***	0.279**
	–	(0.113)	(0.113)	(0.113)	(0.019)	(0.126)	(0.022)	(0.021)	(0.022)	(0.108)	(0.107)	(0.114)
TO*MICD	–	–	–	–	-0.131***	–	-0.152***	-0.153***	-0.155***	-0.363***	-0.357***	-0.362***
	–	–	–	–	(0.023)	–	(0.026)	(0.026)	(0.027)	(0.129)	(0.128)	(0.134)
Foreign direct investment (FDI)	–	-0.007**	-0.007**	-0.008***	-0.020***	-0.10**	-0.018***	-0.020***	-0.206***	-0.004**	-0.006**	-0.006**
	–	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)	(0.006)	(0.005)	(0.006)	(0.002)	(0.002)	(0.003)
FDI*MICD	–	–	–	–	0.015**	–	0.010	0.012*	0.012**	0.001	0.002	0.002
	–	–	–	–	(0.006)	–	(0.008)	(0.007)	(0.006)	(0.004)	(0.004)	(0.004)
Technology-augmented imports (TAIM)	–	–	0.116***	0.118***	0.108**	0.135***	0.128**	0.133**	0.143**	0.008	0.011**	0.015**
	–	–	(0.043)	(0.043)	(0.051)	(0.049)	(0.057)	(0.057)	(0.060)	(0.028)	(0.005)	(0.007)
TAIM*MICD	–	–	–	–	-0.111	–	-0.131	-0.125	-0.183	-0.010	-0.007	-0.032
	–	–	–	–	(0.088)	–	(0.098)	(0.097)	(0.121)	(0.048)	(0.048)	(0.050)
Gross fixed capital formation (INV)	–	–	–	–	–	-0.198*	-0.553**	-0.550**	-0.572***	-0.006	-0.011	-0.007
	–	–	–	–	–	(0.108)	(0.199)	(0.197)	(0.208)	(0.097)	(0.096)	(0.101)
INV*MICD	–	–	–	–	–	–	0.489**	0.487**	0.519**	-0.048	-0.041	-0.013
	–	–	–	–	–	–	(0.232)	(0.230)	(0.239)	(0.114)	(0.113)	(0.117)
Female labour force participation rate (FLP)	–	–	–	–	–	-1.188***	-1.167***	-1.157***	-1.171***	-0.303***	-0.302**	-0.317**
	–	–	–	–	–	(0.304)	(0.323)	(0.322)	(0.328)	(0.159)	(0.158)	(0.161)
FLP*MICD	–	–	–	–	–	–	1.354*	1.389*	1.460**	0.393	0.392	0.455
	–	–	–	–	–	–	(0.723)	(0.720)	(0.739)	(0.356)	(0.353)	(0.361)
Overall significance	2.81	14.63	21.99	22.00	66.45	43.28	93.19	97.72	108.93	49.47	55.11	69.51
Prob> chi2	[0.094]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Interaction effect	–	–	–	–	45.56	–	45.31	48.22	46.28	24.35	21.78	19.05
Prob > chi2	–	–	–	–	[0.000]	–	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.004]
Time effect	–	–	–	–	–	–	–	–	15.01			15.28
Prob > chi2	–	–	–	–	–	–	–	–	[0.822]			[0.808]
Hausamn test statistics	–	–	–	–	2.71	0.66	1.96	2.46	4.82	1.99	1.88	4.36
Prob > chi2	–	–	–	–	[0.952]	[0.995]	[0.999]	[0.998]	[1.000]	[0.999]	[0.998]	[1.000]
R^2	0.005	0.031	0.047	0.047	0.130	0.105	0.203	0.212	0.242	0.119	0.132	0.168
No. of observation	518	460	454	454	454	376	376	376	376	376	376	376

Note: (a) 'skilled-unskilled' wage ratio is defined as the ratio of average wage per worker in top 10% of industries to the bottom 10% of industries. (b) In model (7'), (8'), and (9), dependant variable, (growth of) 'skilled-unskilled' wage ratio is calculated as the ratio of average wage per worker in top 20% of industries to the bottom 40% of industries. Corresponding export intensity and total trade intensity appear as independent variables. (c) MICD stands for middle-income country dummy. (d) In addition to the variables appear, Model (9) is estimated by introducing 25 year dummies. Standard errors are in parentheses while probability statistics are in brackets. The significance level of 1%, 5%, and 10% are indicated by ***, **, and * respectively.

developing countries cannot be ruled-out since a substantial part of technological development is rapidly diffused into most developing countries through the imports of machinery and equipments. To capture the effect of technology on wage inequality, we introduce the technology-augmented imports (TAIM) of machinery and equipment into model (3) through (9). And its interaction term (TAIM*MICD) enters into model (5), and model (7) through (9) to examine whether the effect of technological imports on wage inequality differ between LICs and MICs. The estimated coefficient of TAIM is 0.116 (s.e. 0.043) and is statistically significant at 1% level of significance in model (3). Similarly, the estimated coefficient is positive and statistically significant at 5% of less than that level of significance in the rest of the models. This result is equally held for both country groups since in none of the models the estimated coefficient of the interaction term is statistically significant at the conventional levels. This result implies that technological diffusion widens the skilled-unskilled wage gap in developing countries. In developing countries, the demand for skilled-workers increased rapidly due to the importation of new machinery and equipments since technology developed by industrialized countries is skilled-baised[26]. The higher relative demand for skilled-workers puts up-ward pressure on relative wages since the supply of skilled-labour slowly increase in developing countries. This result is consistent with both theory and previous empirical evidence[27]. Avalos and Savvides (2006) found a positive association between imports of machinery and wage in equality for a cross-section of Latin American and East Asian countries. Similarly, Ramaswamy (2008) found that skilled-biased technological change (STBC) is responsible for the substantial fraction of the increase in wage inequality in Indian manufacturing sector over the period or 1981-2004.

We introduced gross fixed capital formation (INV) into the regression model (6) through (9) to examine the effect of physical capital accumulation on wage inequality. The estimated coefficient of INV is negative in all the models and is statistically significant either at 5% level of significance or less than that level except in model (6). A negative association implies that increase in physical investment in developing countries favors unskilled-labour or in other words, new investments are labour-intensive in nature. Although there is some possibility in the case of LICs, our finding is less convincing in the case of MICs. Hence, we introduce an interaction term (INV*MICD) to examine whether the effect of INV differ between the LICs and MICs. The estimated coefficient is positive and is statistically highly significance implying that capital goods are complementary with skilled-workers in MICs[28]. This result is consistent with recent empirical evidence on capital accumulation and wage inequality. For instance, Acosta and Gasparini (2007), using a micro-data set of manufacturing firms in Argentina, found that skilled-unskilled

26) See Acemoglu (2003).
27) See Acemoglu, (2003), Avalos and Savvides (2006), Behar (2007), Goldberg and Pavcnik (2007).
28) Krisell *at al* (2000).

wage differential is higher in manufacturing industries that invest heavily in machinery and equipments.

The growth of female labour force participation (FLP) is used as a proxy for the relative-laour supply of skilled-unskilled labour in the model. This variable enters to model (6) through (9). As expected in the theory, the estimated coefficient of FLP is negative and statistically significant at the conventional levels of significance. For instance, in model (9) the estimated coefficient of FLP is -1.171 (0.328) and is statistically significant at 1% level of significance. This implies that increase in relative labour supply of skilled-unskilled labour puts pressure on wage differentials to narrow down. This is commonly referred as wage-compression effect of relative labour supply[29].

The robustness of our results is checked against an alternative measure of 'skilled-unskilled' wage ratio. This time we used somewhat a broader measure of wage inequality, ratio of average wage per employee of top 20% of industries to the bottom 40% of industries. We estimated the model (7) through (9) with this new dependant variable and reported the results under Model (7') through (9') in table 3. It can be noted that many of our previous findings are held even under the broader measure of wage inequality. Further we examine whether our results are sensitive to the inclusion of countries have higher per capita income, namely Hong Kong, Republic of Korea, and Singapore[30].

Accounting for the Wage Inequality in LICs and MICs

In this section, the mean difference of wage inequality between the LICs and MICs is decomposed into its contributing factors. Following Easterly and Levine (1997), a variant of model (9) is estimated without interaction term for the period of 1996-1989, 1990-2002, and 1976-2002. Each estimated coefficient is then multiplied by the mean difference of respective variables in order to obtain the relative contribution of each factor. The results are reported in table 4. A greater proportion of the mean difference of 'skilled-unskilled' wage ratio during 1976-2002 can be explained by three main factors, namely trade, technology, and relative labour supply. The mean difference of the growth of relative labour supply, between the LICs and MICs, accounts for the 38% of the mean difference of the wage ratio. Many MICs in recent years experienced a relative scarcity in unskilled-labour since the growth of relative labour supply is high. This relative scarcity of unskilled-workers and the higher growth of skilled-workers narrow down the skilled-unskilled wage ratio in MICs. Hence the difference of the growth of relative labour supply accounts for a substantial portion of the mean difference of

29) See Robbins (2003).

30) We include these countries into our sample since in most of the years Hong Kong, Republic of Korea, and Singapore are classified as developing countries.

'skilled-unskilled' wage ratio.

Table 4: Accounting for the difference of skilled-unskilled wage ratio between LICs and MICs[a]

Contributing factors	*1976-1989*	*1990-2002*	*1976-2002*
Export intensity	6.21%	0.32%	0.87%
Trade openness	16.86%	16.09%	9.59%
Foreign direct investment	4.58%	0.27%	1.24%
Technology imports	16.61%	7.86%	33.26%
Gross domestic investment	0.62%	0.01%	2.39%
Relative labour-supply[b]	0.28%	55.13%	38.17%
Residual (time-effect)	54.83%	20.31%	14.46%

Note: (a) The 'skilled-unskilled' wage ratio is the ratio of average wage per employee in top 10% of industries to the bottom 10% of industries. (b) Female labour force participation is the proxy variable for the relative labour supply.

In contrast, the difference of the growth of technology imports accounts for 33% of the mean difference of the wage ratio. The LICs heavily depends on imported technologies. In contrast, dependency on imported technologies is less in MICs since they develop their own technologies that are finely fitted into their relative factor abundance. The growth of trade openness has been responsible for the 10% of the mean difference of the wage ratio. This difference may be due to the fact that the effect of trade openness differs between the two country groups and the growth of the trade openness is higher in MICs. Interestingly, our findings are consistent with the previous literature. Avalos and Savvides (2006) found that the mean difference of the wage ratio between Latin American and East Asian countries could be explained by factors such as trade, technology, and relative labour supply.

6 . Conclusion

Since the early 1980s, many developing countries embarked on liberalizing their trade and investment regimes in order to accelerate economic growth on the one hand and to achieve a more equitable distribution of income on the other hand. As expected, many liberalized countries have been able to achieve higher economic growth rate during the post-liberalization period. However, on the contrary to the expectation, many of those countries experienced rise in wage (income) inequality. Consequently, the debate on the causes and implications of wage inequality has been at the forefront academic debate.

With the intention of contributing to this debate we examine the determinants of wage inequality for a sample of developing countries. We found that variables representing trade, technology, and relative labour supply play key roles in determining the level and growth of skilled-unskilled wage differential in the sampling countries. In other words, globalization

process is largely responsible for the rapid rise in relative wages in the developing world. Moreover, the effects of trade openness, FDI, and capital accumulation on the direction of the wage differential differ between LICs and MICs. It is found that much of the mean difference of the wage ratio between the LICs and MICs could be explained by the difference of trade openness, technology, and relative labour supply.

The promotion of education and training is one of the key tools in countering skilled-unskilled wage differential in LICs. In recent years, demand for skilled labour has rapidly been increased in LICs due to the expansion of exporting activities and importation of new technology. However, supply of skilled-labour has been grown at a slow space.

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Appendix A: Manufacturing Industry Classification: International Standard Industry Classification (ISIC) Ver. 2

ISIC Code	ISIC Description
311/312	Food manufacturing
313	Beverage industries
314	Tobacco manufactures
321	Manufacture of textiles
322	Manufacture of wearing apparel, except footwear
323	Manufacture of leather and products of leather, leather substitutes and fur, except footwear and wearing apparel
324	Manufacture of footwear, except vulcanized or moulded rubber or plastic footwear
331	Manufacture of wood and wood and cork products, except furniture
332	Manufacture of furniture and fixtures, except primarily of metal
331	Manufacture of wood and wood and cork products, except furniture
332	Manufacture of furniture and fixtures, except primarily of metal
341	Manufacture of paper and paper products
342	Printing, publishing and allied industries
351	Manufacture of industrial chemicals
352	Manufacture of other chemical products
353	Petroleum refineries
354	Manufacture of miscellaneous products of petroleum and coal
355	Manufacture of rubber products
356	Manufacture of plastic products not elsewhere classified
361	Manufacture of pottery, china and earthenware
362	Manufacture of glass and glass products
369	Manufacture of other non-metallic mineral products
371	Iron and steel basic industries
372	Non-ferrous metal basic industries
381	Manufacture of fabricated metal products, except machinery and equipment
382	Manufacture of machinery except electrical
383	Manufacture of electrical machinery apparatus, appliances and supplies
384	Manufacture of transport equipment
385	Manufacture of professional and scientific, and measuring and controlling equipment not elsewhere classified, and of photographic and optical goods
390	Other Manufacturing Industries