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Kaiyao Xu
Skidmore College

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**The Impact of Trade Liberalization on the Gender Wage gap in the
Labor Market**

Kaiyao Xu

May 3rd, 2017

I - Abstract

This research mainly focuses on the impact of trade liberalization on the gender wage gap in the labor market. Collecting the evidences from countries in a worldwide range, the impact of trade liberalization on gender wage gap is supposed to be analyzed on a domestic industrial level. An empirical OLS estimates model is applied inside the U.S. domestic labor market. The data comes from PSID data base of 1985 and 1995. Linking the empirical result to the industrial shift and labor structure shift caused by trade liberalization, the relationship between trade and gender wage gap can be discussed and concluded.

II - Introduction

Generating the evidences from several countries, such as the United Kingdom, China, India, and Mexico, the relationship between trade and gender wage gap on the national level is observed to vary from countries. From literatures, the trade liberalization is linked to have an influence on the gender wage gap through its impact on the industrial structure and the labor structure change inside industry. After the economic recessions in early 1980s, the U.S government advanced the trade liberalization by reaching several trade agreements with other countries in 1980s and started the establishment of World Trade Organization (WTO) in 1990s. During this trade liberalization period, the rapid economic growth led to a significant job growth inside the United States, while the international labor flows caused an uneven distribution of this domestic job growth in the labor-intensive and non-labor-intensive industries. Moreover, another key factor is technical development which caused the labor structure shift inside the industries. According to the technical development, there appeared a labor demand shift for skilled and unskilled workers. Therefore, besides gender as the fundamental individual indexes, the workers' education level should be focused as another important factor. In the OLS estimates model

applied in this empirical research, income from wages and salaries is used as dependent variables, while other basic variables including education and gender are considered as independent variables. The gender wage gap can be observed through the comparison between coefficients of male and female groups. The empirical results show different trends of gender wage gap from 1985 to 1995 under the trade liberalization, which is related to the industrial shift caused by trade liberalization.

III – Analytical Framework

By collecting and comparing the evidences all over the world (which will be discussed in the literature review part later), the impact of trade liberalization on the gender wage gap in the labor market varies from countries. On the national level, in some developing countries, the trade liberalization leads to larger gender wage gaps; while in some other developing countries, the trade liberalization narrows down the gender wage gap. This variety can also be observed among developed countries, indicating that the relationship between trade liberalization and gender wage gap does not simply depend on the countries' development degrees. It is understandable that the national level measurement might leads to an abstract consequence. In 1980s and 1990s, international trade liberalization caused the major worldwide labor flows between developed and developing countries. However, the increased labor demand in developing countries and the decreased labor demand in developed countries are not evenly distributed through industries. For instance, in the case of China, the trade liberalization brought a large demand of strong labor force from the overseas. Before the woman were liberated, of course, the male group occupied most of labor intensive industries and was the major labor supply in the market. In this way, the trade liberalization mostly contributed to the job growth in the male group and therefore

increased the gender wage gap in the national level (for the urban area in China developed at a much higher speed than the rural area did). Moreover, due to the technical development, in most of the technique related industries, especially some emerging industries such as computer science, the demand of skilled and unskilled worker shifted. In the case of China, the higher educated group mainly consisted of male workers which also contributed to the increase of gender wage gap. In another case of England, the unskilled female workers were hurt mostly, because the demand of strong labor force shifted from domestic labor market to the developing countries whose labor were much cheaper, and the domestic technical development raised the requirement for workers' education levels and working experiences. Inside the United States, for instance, the mining industry was mainly occupied by male workers and was severely hurt by the economic recessions in early 1980s. In addition, trade liberalization in 1980s and 1990s led to the decreased demand of strong labor force in the mining industry, which contributed to a decrease in the national male wage level. From these evidences, it is clear that the national level gender wage gap is actually formed by the changes of the gender wage gaps in each industry combining with the different gender proportions of each industry. The gender wage gap was mainly influenced by the shift of labor demand which depended on the job growth distribution on the industrial level by trade liberalization. Therefore, it is necessary to have an empirical measurement of the gender wage gap in different industries and combine this individual level measurement with the industrial level labor structure shifts to find the relationship between trade liberalization and gender wage gap. In the following part, the impact of trade liberalization on the gender wage gap will be discussed in detail using the evidences of different countries. There are also some researches exploring the uneven job growth distribution and focusing on the labor structure shift in the domestic market which are caused by trade and technical development.

$$\ln(\text{wage}) = \beta_0 + \beta_1 \text{age} + \beta_2 \text{agesq} + \beta_3 \text{edu} + \beta_4 \text{child} + \beta_5 \text{marriage} + \beta_6 \text{sex} + \varepsilon$$

The equation above shows a rough concept about the relationship between wage and other individual indexes. As for the independent variables, 'age' comes from the actual age of individuals, 'agesq' is generated as the square of age for a quadratic relationship prediction, 'edu' is the current highest education completed by individuals, and 'child' is the number of children in a family unit representing as the family size in this case. Other two dummy variables 'marriage' and 'sex' represent the marital status and gender information of the individuals, respectively.

Wage comes from the actual amount of income from wages and salaries in whole U.S dollar. The concern of taking log of wage as dependent variable instead of direct wage variable is for the convenience of observing the change of wage under the impact of independent variables.

IV - Literature Review

In the early 1980s, there were two recessions in the United States which depressed the economy on a worldwide range. After the crisis, the global market had an economic recovery and trade played a crucial role in this process. A lot of data shows that the global output rate had grown rapidly since 1983 (WTO Release, 1996), and in some trade active countries, such as the United States and China, the amount of imports and exports took large proportions of their GDPs (WTO Release, 1996). Trade liberalization can lead people to a higher productivity, a higher income level, and therefore a higher living standard. Countries trade with each other, and as a result, citizens in different countries can get a greater variety of goods and services which may not originally be able to be produced on their own lands because of certain environmental

limitations. Another thing trade benefitted was the level of employment. Numerous job opportunities were created by trade which stimulated the depressed market a lot.

However, it is reasonable to suspect that there is a relationship between trade liberalization and the gender wage gap in the labor market, as trade liberalization may cause a shift in the demand for labor and subsequently cause a wage structure change. As the data, the growth of the employment rate was very unevenly distributed in the recovery period. For instance, in the United States, the job growth mainly took place in service and retail industries. The job growth rate remained almost the same in government related fields, while some manufacturing and mining industries even showed negative job growth rates (Lois M. Plunkert, 1990). This uneven distribution of job growth caused the changes in the gender wage gap. The goal here is to analyze what the key determinants in the gender wage gap are and how does the trade influence the gender wage gap through those key determinants.

First of all, in the industry level, trade and technology are the two factors that influenced the market most (Lois M. Plunkert, 1990). As the trade liberalization linked the global market together, sources around the world became more accessible and the markets in different regions were able to specialize in the fields they were good at. As the technology developed fast, there was a change in the labor demand proportion and therefore, led to some wage structure shifts. For the individual level, there are several basic indexes such like age, education level, work experience, and marital status, and of course, gender. The individual achievement determines the worker's positions in the market and in a macro view, determines the proportion distribution of workers from different ages, education levels, and gender. As I just mentioned, the trade shifted the labor market structure. From some literatures, the unskilled workers in developed countries were hurt by the technical improvement and the import competition from developing countries.

Depending on the gender proportions of those skilled and unskilled groups, the gender wage gap tended to show different reactions to the trade liberalization. And even in different industries, depending on their demand for labor and technical progress, the trend of gender wage gap varies. This is also the major content that I am going to mention through the whole paper. As the conclusions from many literatures show different effects of trade liberalization and indicate that the relationship between trade liberalization and gender wage gap does not depend on whether a country is developed or not. This reminds us to actually combine the effect of trade and technology on industries with the gender proportions respect to the occupations.

In order to convince the reader and give a comprehensive understanding in this trade liberalization and gender wage gap relationship, there are going to be several evidences from different countries around the world.

Evidence from India

Consider the wage structure in the labor market of India, 'Trade Liberalization and Wage Inequality: Evidence from India' (Kumar and Mishra, 2008). They indicated through their research results that the trade liberalization has a negative effect on the wage inequality. On the firm level, trade liberalization increases the wage premium and then influences the individual level, as long as the workers are heterogeneous. The researchers establish two stage methodologies: OLS (Ordinary Least Squares) estimates regression model and the weighted regression model, for the individual level and industry level, respectively. While in the OLS estimates model, they regress the individual wage on age, education, and gender. In the weighted regression, they focus on the relationship between wage and tariffs, including other tariff related factors. The result implies an increase of the wage inequality associated with the trade liberalization.

Evidence from Mexico

Compared to the evidence from India, the impact of trade liberalization varies between countries and does not depend on the degree of development. In this case, 'Effects of Trade Liberalization on the Gender Wage Gap in Mexico' (R. Artecona and W. Cunningham, 2002), researchers focus on the change in the gender wage gap in the manufacturing sector in urban Mexico over the trade liberalization advanced period. They build up the OLS regression model, with the percentage change of individual wages as dependent variable and individual education level as the independent variable. As for the concern of nonlinear relationship between these two variables, an N-shaped (or S-shaped) population regression model is applied in this case. The model regresses the percentage change of wage on education (squared, cubed). Then they apply a pooled sample from male and female full-time employees in a certain sector comparing the period before trade policy and the period after trade policy. The gender wage gap is represented in those error terms. The results indicate an opposite impact of trade liberalization in Mexico from the evidence of India.

Evidence from Other Developing Countries

As for the developing provinces and countries, it is observed in Taiwan and South Korea that the reduction of gender wage discrimination is mainly caused by the increasing competition from international trade rather than from the domestic pressures (Gunseli, 2004). This result follows the neoclassical theory which states that the increase of industry competitiveness can lessen the discrimination against women. Compared to Taiwan and South Korea, in Egypt, an evaluation of the impact of trade liberalization on the gender wage gap uses the data from Egypt Labor Market Panel Survey (ELMPS). The analysis gives us a panel result from an OLS regression showing that in the trade related sectors, the gender wage gap from pure discrimination has been

increasing between 1998 and 2006, while in the unrelated sectors, gender wage gap of pure discrimination had been declining so far. This is interesting and provides evidence against the neoclassical theory which supports that increased competition in trade may lessen discrimination against women (Fatma El-Hamidi, 2008).

Another research, 'The impact of trade liberalization on wage inequality: evidence from Argentina', studies the trend of wage inequality and trade flows from 1980 to 1998 in Argentina (Galiani and Sanguinetti, 2003). In this research, they first show that the wage inequality increases in tandem with trade liberalization policy. They then search the data in an effort to explain this correlation on several aspects. They explore the difference on gender and education level among individuals, and the difference on trade related industries and labor demanded in the market for skilled and unskilled workers for the industry level. The exploration is comprehensive and observes most of related factors which shows the effect of trade liberalization on wage inequality as accurate as they can.

Evidence from China

In most of the urban districts in China, the wage inequality has been increasing comparing the datasets of 1988 and 1995 (John K and Lina S, 2003). In 1988, the gender wage inequality in urban areas was at a low Gini coefficient of 22.9 percent. However, alongside worldwide trade policy, the establishment of the World Trade Organization started led to marketization in Chinese urban areas. Market productivity increased rapidly at that time, though growth of the gender discrimination occurred as well. In 1995, the Gini coefficient rose to a 30.7 percent. The efficiency – inequality trade-off graph indicates that the gender wage inequality was mostly caused by the shift of labor market from being administered to more efficient, even though the growth of efficiency was diminishing. As two of the key factors, technology and trade, widely

changed in the Chinese labor market, this led to a larger demand of the labor who were stronger and were able to work for a longer time, while the technology development in this case, led to a more skilled and higher educated labor demand. Combining with the labor supply proportion at that time, male workers took a larger proportion than female workers did both in the unskilled labor group and the more skilled group. As for the high educated level, there was a significant gap between the male and female labor supply proportions. In this way, though the unemployment rate rapidly decreased from 1988 – 1995, the gender wage gap was caused by the labor demand shift result from the request for higher productivity.

It is a nice comparison to the literature we will discussed later, ‘How trade hurt unskilled worker’ (Adrian W, 1997). The relationship between trade liberalization and gender wage gap in the labor market, as we collected above, often varies between countries. Here by the analysis of labor structure change, we may raise a hypothesis that, indeed, it is the shift of labor demand and the gender proportion of labor supplied in different education (which can be also regarded as skill-related.) levels and industry fields, that can determine the effect of trade liberalization.

Gathering all the evidences above together, there is now a rough framework about how the trade liberalization influences the labor market. And most of these literatures prefer the OSL regression model as their tools to deal with the sample population. However, to keep the regression result as reliable as possible, there must be other factors that we need to take into account, in order to figure out the real partial impact of trade liberalization. Following will be some literatures focusing on the determinants on either firm level and individual level.

So far, we have sufficient evidences supporting the hypothesis that the impact of trade liberalization is not determined by the degree of development. We need to look deeper into the detailed correlation between trade related factors and individual indexes.

Some Macro and Micro Determinants

There are some scholars looking at the more specific individual indexes in the labor market related to the trade liberalization. One of the concerns is the shift of labor demand for more skilled workers. Adrian Wood (1995) points out in 'How Trade Hurt Unskilled Workers' that during 1990's, the labor demand of unskilled worker rapidly fell down in the developed country. While the labor demand of unskilled worker in the developing country dramatically increased. This trend was more significant in the manufacturing industries than in other industries. Several figures imply that this trend is clear, even though the magnitude might not be big enough. It is understandable that because of the trade liberalization, several labor resources from developing countries with large quantity and low cost become accessible by the developed countries. Those large international companies no longer prefer the domestic higher-cost labor and therefore the labor demand rapidly decreases in developed countries. At the same time, in order to improve productivity, more skilled workers are needed for technological development. This shift is most dramatic in manufacture industries which have a larger labor demand compared to other industries.

The shift of wage structure can be explained in 'Changes in Relative Wages, 1963-1987: Supply and Demand Factors' (F. Katz and H. Murphy, 1991). Focusing on the period from 1963 to 1987 in the United states, a simple framework of supply and demand in the labor market shows this shifting clearly. Based on the data from Current Population Surveys (CPS) for individual wage measurement and the regression on factors such as age, education, gender, and working experience, it is significant that the wage rate for higher education level grows faster than the wage rate of lower education level. As work experience can be regarded as an index of

skill, the regression result indicates a decrease in the demand for unskilled workers, more dramatically for the male worker.

As the labor demand in developed countries shift to the more skilled worker (Adrian Wood, 1995), education level is also regarded as one of the most important determinants in the wage gap. Though there is not a significant evidence concluding that the trend of greater wage inequality is tightly related to the increased import competition, it is supported by the Bureau of Labor Statistics data (Baldwin and Gain, 1997) that the U.S. labor market has an increase of labor demand for 1 – 11 years of schooling in import products in 1980s. So in the US, wage inequality has increased with greater labor demand but in Taiwan and South Korea. And due to the technology progress, there is a larger demand of higher education labor especially in the manufacturing sectors.

Industry shifts in the United States

Besides the labor market shift in China we mentioned last week, there were some industry shifts in the United States as a result of trade liberalization. In his report of 1980s' job growth and industry shifts, Lois M. Plunkert provided us a framework about the correlation between the uneven job growth and the industries shifts. And his work is highly related to the hypothesis made in previous content. Combining the industry shifts with the gender proportion for each field, we can analyze the impact of trade liberalization on the gender wage gap specifically. The two recessions that happened in the early 1980's hurt most of the manufacturing and mining industries. Some of these industries could never recover after the crisis while others raised back to its previous productivity but still lost its labor participated in the market. While most of the employment rate growth took place in service and retail industries. In the 1950s, there was a 41 per cent of nonfarm jobs in the manufacturing industries and in 1990s, it reduced to a 24 per

cent. Data shows the mining industries lost 25 per cent of its workers while the manufacturing industries lost 7 per cent. Even under the overall job growth, the employment changes decreased in 1979 to 1989 in industries such as finance, insurance, real estate, wholesale trade, construction, transportation and public utilities. However, some industries met the chance and had a rapid development. The industry which advanced most was computer and data processing service. The second was outpatient care facilities, while the third was personnel supply service. This phenomenon indicates the theory mentioned previously that the technical development leads to a higher basic skill requirement. The new occupations were created and therefore it hurt the unskilled workers in the old manufacturing industries.

Another cross-section examination of the impact of trade liberalization on the labor movement (Romain Wacziarg and Jessica Seddon Wallack, 2002). There is a brief review of models which illustrate the benefit of trade liberalization. Just as mentioned before, the shift from restricted to open trade enable countries to reorganize the resources and focus on the field they have comparative advantages. Those comparative advantages can be the higher technical achievement in the Ricardian model, or the different relative factor endowments in Heckscher – Ohlin model. In some models, the trade liberalization gathers the production of some certain areas together, and in this way, change the market structure in a national level. At the same time, some other theoretical models suggest that there is no involvement of labor structure change in the trade liberalization. Among those contracting theories, there is a lack of reliable research in the sectoral level for the impact of trade liberalization. This literature uses the data from the United States Industrial Development Organization (1997), and International Labor Organization (1997), which I think are good data sources to be included in my measurement later in the methodology part. And it also provides a list of trade liberalization degree for countries. And

then combining with the labor response, they do the analysis for each country. This methodology gives a significant more accurate and comprehensive relationship between trade and industry shifts.

Human Capita Adjustment in the United States

Besides the evidence of how trade liberalization hurt unskilled workers from the United Kingdom, there is an evidence from the United States (Falvey and Greenaway, 2010). In this case, there are two sectors, skilled and unskilled worker and a two-sector Heckscher-Ohlin trade model is applied with an education sector using skilled labor and time to convert unskilled workers into skilled workers. Under this model, it does not only show the shift of labor demand to the skilled worker, but also measures how the characteristics of unskilled workers effect their needs for skill upgrading in response to the labor structure changes. There is a measurement for the return to upgrading and it turns out that not all the upgraders are better off. Most of young upgraders gain from the skill upgrading. For higher age level, the return to skill upgrading reduces while the oldest workers remain unskilled and therefore lost. This analysis gives us a further sense that the group of unskilled and old workers is hurt by the trade liberalization most. It points out the lack of skilled labor supply and the importance of on the job training. This article pictures the trend that the labor supply changes to meet the requirement of demand in order to reach the market balance (idealism).

U.S. Trade Policy in 1980s and 1990s

After the economic recession, the U.S trade deficits kept growing from 1985 to 1995. In 1985 – 1995, U.S. kept the position as one of the largest import and export countries. The trend of trade liberalization maintained the same in most of manufacturing sectors. The U.S. government advanced in trade liberalization (Martin Feldstein et. al, 1994) and therefore the amount of

manufacturing imports such as electronics became much larger than the amount of export at that time which is related to the global impact of trade later. And as trade became more and more important in the U.S. economy, the percentage of trade contributing to GDP increased from 17.2 percent in 1985 to a 20.6 percent in 1990 and then reached 23.6 percent in 1995. The open market played a key role in the U.S. economy recovering and was a major element in maintaining the productivity growth (WTO Release, 1996).

The United States did not slow down the speed of trade liberalization after the economic recession (1981 - 1982). Instead, the U.S. government accomplished more international trade agreements in the following decade. The United States completed trade agreements with Israel in 1985, with Canada in 1989, and with NAFTA, which is a trade line though the United States, Canada and Mexico, in 1994. The tariff reduction took place after the Uruguay Round negotiation which added several agreements of tariff reduction in most of the U.S industries. From many U.S trade policy review, though the marginal benefit of tariff reduction had decreased, the overall benefit of trade liberalization was still positive. However, as we mentioned before, because trade liberalization shifts the labor demand and supply structure, domestic producers in labor-intensive manufacturing industries stood against the import advance. On the other hand, producers in most export related fields, including agriculture, highly supported the reduction of export barriers. The share of imports in GDP increased from 9% - 10% in 1985 – 1995, while the share of exports increased from 5% - 7% for the same period. In addition to the Uruguay Round negotiation, the agreement to establish the World Trade Organization was signed in 1993, which had an immediate and significant impact reflected in worldwide export growth. (68% faster than the global GDP in 1980s, and 140% faster than the global GDP in 1990s.). The general consensus in the literature is that the benefit of trade liberalization in the

late 20th century was greater than the cost of market adjustment, even after taking the increased import competition into account. Though many of these prior studies introduced models to study the impacts of trade liberalization, a need for further quantitative examination still exists.

The Global Impact of Trade Liberalization

(A review for 'Trade and Development Report, 1985', United Nations)

While the trade liberalization was advanced by the U.S. government through the trade agreements mentioned above, the international trade liberalization brought impact not only to the United States, but also to the other developed and developing countries through international labor flows. Though the trade liberalization benefits the United States, the global trade liberalization was uneven and therefore led to a complex impact towards different countries. Under the economic recession, the rate of world output growth was at 2 percent in 1983. Then the growth rate rose to 4.3 per cent in 1984. Output growth rates were at a high level for most Eastern European countries, Japan and Canada. At the same time, with a high unemployment rate, the Western European countries had a comparably low output rate. At a pace of reduction, developing countries in East Asian retained a relatively high output rate and the developing countries of the Western Hemisphere had a dramatic growth from a negative 2.4 percent to a positive 2.6 percent. Following the import and export growth of the United States, there existed an increase of import demand which was also uneven in the developing countries. This uneven distribution led to three types of shifts. Firstly, some developing countries in Pacific Basin were not influenced by the debt-servicing crisis much and had dramatic export and import increases brought by the United States. Secondly, due to low productivity and the weak commodity market, a large number of developing countries were not able to catch the change and therefore failed to have any significant import or export growth. Lastly, the group of developing countries

in Latin America suffered from the debt-servicing crisis. Therefore, the exports in those countries increased sharply after the recession. Due to the depressed external market, there were large cuts in the imports.

V - Data and Methodology

Before establishing the empirical model for this research, there are literatures offering some references for the methodologies of measuring the gender wage gap in the labor market.

As a precedence for measuring the gender gap across the countries (D. Blau and M. Kahn, 1992), Blau and Kahn established the empirical Ordinary Least Square model. The model runs the regression of percentage change of wage on dummy variables such as part time or full time job, marital status, and whether the family has children (family size). The model includes several countries and therefore has a cross-section dataset. They also divide the samples in each country into groups: male single worker, male married worker, female single worker, and female married worker, and then applies the regression function for each group. This division gives the empirical examination for each group, and comparing the coefficients; difference between groups, the wage gap between male and female groups and the wage gap between married and unmarried group are shown respectively.

In addition to the basic Ordinary Least Square model, there is an extension adding the discrimination into consideration, given in 'Male-Female Wage Differentials in Urban Labor Markets' (Ronald Oaxaca, 1973). In this study, the researchers measure the discrimination by using male to female wage ratio by building up the equations. Also for the non-discrimination condition, the ratio of the marginal product of males to the marginal product of females can be represented as the male to female wage ratio. And in the methodology, the difference between

ratios of the discrimination situation and non-discrimination situation indicates the scale of discrimination degree. Besides using the male to female wage ratio to measuring the discrimination, the model contains other basic individual indexes as independent variables into concern. By adding weights to these variables and using a higher-level method based on OLS regression, a more accurate examination of the partial impact of basic individual indexes on the wage level is shown in the regression results.

Inspired by the methodologies mentioned above, Ordinary Least Square regression model serves as the fundamental method of testing the correlation between wage level and basic individual indexes in this research. Basic individual indexes are concerned as age, education, gender, marital status, and the family size. As it has been mentioned in the analytical framework part, because the trade liberalization leads to an uneven job growth distribution and therefore causes the industry shifts in the domestic labor market, it indirectly changes the labor demand structure and therefore the wage structure in each industry to different degrees. It is necessary to have an industrial level examination and use a cross section data set based on different industries. Moreover, in order to detect the trend of gender wage gap through a certain time period, the OLS regression model is applied for two time points. Then the comparison between the regression results of two time points can show how much degree does the gender wage gap change during this time period. Based on the trade policies reviewed in the previous content, it is known that in 1980s and 1990s, the trade liberalization was advanced by the U.S government after the economic recessions in the early 1980s. In this way, we choose year of 1985 and year of 1995 as two time points. Running the OLS regression function for each year, and comparing the difference between the partial impact of gender on the wage level of 1985 and 1995, the trend of gender wage gap can be detected. The data is collected from Panel Study of Income Dynamics

(PSID) data base in time slots 1985 and 1995. And the information of variables is shown as the followings:

Wage – collected from the PSID family level data base, is the Head's income from wages and salaries in the past whole year. The values for this variable in the range 1-999998 represent the wage income in whole dollars. Codes '1 - 999,998' represent the actual amount of income, '999,999' represents \$999,999 or more, '0 Inap' represents no wages or salaries information for the individual.

Age – collected from PSID family level data base, is the actual age of the head of each family unit. The value of this variable usually ranges from 18 through 98, although in rare cases a person under 18 might become head. Codes 16 - 97 represent the actual age, 98 represents ninety-eight years of age or older, while 99 indicates the information of age for the individual is not answered.

Education – The values for this variable represent the actual grade of school completed; e.g., a value of 08 indicates that this individual completed the eighth grade by the time of the 1985 interview.

Family Size (Children) – collected from PSID family level data base, is the number of children in a family unit. It is defined as the actual number of persons currently in the family unit who are neither head or wife from newborns through those 17 years of age, whether or not they are actually children of the head or wife. The value of this variable range from 0 to 8 in 1985.

Dummy variables:

Marital Status – collected from PSID family level data base, represents the marriage information of head in a family unit. In the data base, there are five categories offered as the marital status: married, never married, widowed, divorced or annulled, and separated. The value

of this dummy variable is defined as 1, 2, 3, 4, 5, respectively for each category, and 9 meaning the information is not answered or not known for the individual.

Sex – collected from PSID family level data base, is the sex of head in a family unit in 1985. In the original dataset, code 1 represents male head while code 2 represents female head.

Industry – collected from PSID family level data base, is the type of business or industry head works in. The value of this dummy variable is defined using the 3-digit industry code from 1970 Census of Population, Alphabetical Index of Industries and Occupations issued June 1971 by the U.S. Department of Commerce and the Bureau of the Census. Followings are the categories and 3-digit industry code:

17 - 28 Agriculture, Forestry, and Fisheries;

47 - 57 Mining;

67 - 77 Construction;

107 - 398 Manufacturing;

407 - 479 Transportation, Communications, and Other Public Utilities;

507 - 698 Wholesale and Retail Trade;

707 - 718 Finance, Insurance, and Real Estate;

727 - 759 Business and Repair Services;

769 - 798 Personal Services;

807 - 809 Entertainment and Recreation Services;

828 - 897 Professional and Related Services;

907 - 937 Public Administration;

999 Not Answered; Do not Know;

0 Inap.: not working for money now at all.

Econometric Model

$$\ln(\text{wage}) = \beta_0 + \beta_1 \text{age} + \beta_2 \text{agesq} + \beta_3 \text{edu} + \beta_4 \text{child} + \beta_5 \text{marriage} + \beta_6 \text{sex} \\ + \beta_7 \text{age} * \text{sex} + \beta_8 \text{edu} * \text{sex} + \varepsilon$$

The OLS population regression function is shown above. This econometric model mainly exam the partial impact of basic individual indexes on the individual wage level by change of percentage. First generate the wage variable as the log of wage and use the log of wage as dependent variables representing the individual wage level in percentage. The constant in the equation represents the wage level for individuals in term of log of wage without counting the partial impact from other independent variables. The variable ‘agesq’ is generated as the square of age. Predicted as a parabola relationship between age and log of wage, age and the square of age are used to measure the partial impact of age on wage. Similarly, ‘edu’ represents the highest education level completed by individuals whose coefficient represents the percentage changes in wage by increasing one unit of education. The coefficient of ‘child’ represent the percentage change of wage by increasing one more child in a family unit. As for the dummy variable, there are intercept dummy variables and slope dummy variables generated in this case. The intercept dummy variables are created as ‘marriage’ and ‘sex’, by resetting the values of variables in the empirical model. As marital status is originally divided into five categories: married, unmarried, widowed, divorced and, separated. In this case, it is rearranged into two categories: married, containing married group and separated group; unmarried, containing widowed, divorces and separated groups, with corresponded values 0 and 1, respectively. In this way, the coefficient of intercept dummy variable ‘marriage’ serves as the difference of wage level between married and unmarried groups. The value of sex is redefined as 1 for male samples and 0 for female samples. Similarly, the coefficient of intercept dummy variable ‘sex’ represents the difference of wage level between male and female groups. Besides the intercept dummy variables, two slope

dummy variables are generated. 'age*sex' is the product of age and gender, while 'edu*sex' is the product of completed education year and gender. If the sample is male, then sex=1 as defined and the coefficient of 'age*sex' adds up to the coefficient of 'age' representing the returning rate of age to wage for male group. If the sample is female, then sex=0 as defined. The term 'age*sex' is omitted in this case, while the coefficient of 'age' serves as the returning rate of age to wage for female group. It is clear that the coefficient of 'age*sex' represents the gender difference of returning rate of age to wage. Similarly, this is how another slope dummy variable 'edu*sex' representing the gender difference of returning rate of education to wage. Same for the intercept dummy variables 'marriage' and 'sex', their coefficients add up to the constant term, if sex=1 for male group and are omitted, if sex=0 for female group. And this is how they represent the difference of wage between groups.

The main reason that adding the slope dummy variables into the model is that, according to literature reviewed, besides trade liberalization, technical development is another fundamental factor influencing the labor demand structure and wage structure. As it is mentioned, due to the technical development in industries such as computer science industry, the demand of labor shifted to the more skilled workers, which is regarded as the higher educated group in this case. By measuring the gender differences of returning rate of age and education level to wage level, the partial impacts of age and education are expected and the gender differences of the population on fixed age or education level show the gender gap under pure discrimination.

IV – Analysis of Results

As this OLS model is applied based on different industrial sections in the domestic labor market inside the United States, the population regression function is run individually based on the PSID categories. By checking the Variance Inflation Factors for all independent variables in

each regression, the VIF values for 'age', 'agesq', 'sex', 'age*sex' and 'edu*sex' are shown larger than 5, indicating the imperfect multicollinearity; while for independent variable 'marriage' and 'child' and variable 'edu' in some of the regression results, the VIF values are detected to have multicollinearity problem. It might be concern as the linear correlation to other variables. Therefore, the independent variables should be reconsidered. In order to detect the heteroscedasticity, the Park's Test is applied for each regression, while the test results indicate a homoscedastic consequence. As the empirical model is not panel, Hausman test does not appear in this case. Using the two-tail test, the significance levels are calculated and marked.

The regression results are shown in the tables individually for each industry in 1985 and 1995 respectively. For convenience, in the following analysis, the numbers are only counted two digits after the point.

In agriculture, forestry and fisheries industry, according to the coefficients of 'sex', gender wage gap increases from 3.04 in 1985 to 11.80 in 1995. Here we should only consider the '_cons', which indicates the start level of individual wage. And it is noticed as an increase of the wage level for the whole sample population. However, the gender gap of returning rate of age to wage decrease from -.07 to -.12 which indicates that in 1985, the female group had more advantage than the male group on the same age level and this advantage became more significant in 1995. The gender difference of returning rate of education to wage decreases from .06 to -.80, which indicates that in 1985, the male group took more advantage than the female group on the same education level, while this advantage shifted opposite in 1995. The results indicate that at the same age and education level, the gender wage gap became larger in both discrimination and non-discrimination conditions. Especially for the male and female workers on the same education level, the gender wage gap became larger by comparing the absolute value of scales.

In the Mining Industry, as the regression result shows, the result of 'sex' is omitted, because of the lack of female workers in the sample population. This result is corresponded to the gender proportion in mining industry, which was mostly male occupied in 1985 and 1995. In this way, the result fails to show the gender difference on wage. According to other coefficients, the mining industry has a labor structure shift. The partial impact of age on the wage is not significant shown in the result, while the partial impact of education on wage has been shown as a decrease from 1.00 to -4.21, indicating a decrease of the returning rate of education to wage.

According to the regression results of the construction industry, the coefficient of education decreases from .34 in 1985 to .27 in 1995 indicating the partial impact of education on wage had decreased, which reflects the labor demand of higher educated(skilled) worker had decreased. This result corresponds to the international labor demand flows during 1985 - 1995 time period, when the demand of unskilled strong labor forces in most of the developed countries was hurt by the import competition of cheap labor force from some developing countries. The decrease of age*sex from -.01 to .06 indicates a large shift of comparative advantage from female workers to male workers. Meanwhile the decrease of edu*sex from -.29 to -.46 indicates a larger gender wage gap with the more advantage of female group took on the returning rate of education to wage.

In the manufacturing industry, which was severely hurt by the economic recessions in the early 1980s and was continually hurt by import labor competition by the trade liberalization, the gender wage gap measured by 'sex' increased from .28 to 2.17, while gender wage gap under pure-discrimination condition (without the partial impact of age and education level), both increased but in the opposite directions with the fixed age level and fixed education level respectively. The comparative advantage of male shifted to the female with respect to the same

age level, while the comparative advantage of male increased with respect to the same education level.

In the transportation, communication and other public utilities industry, the proportions of male and female were more evenly distributed. While the industry was less influenced by the trade liberalization, the job growth rate maintained closed to the steady speed. The gender wage gap under pure discrimination became larger with the comparative advantage of male group on the same age and education level. Combining with the increase of $_cons$, which represents the start level of wage ratio for the sample population, the change of gender wage gap was not as much significant as that in other trade-related industries.

In the whole sale and retail industry, which had a middle level of job growth during 1979 to 1989, had a larger gender wage gap change than that of the transportation, communication and other public utilities industry. The gender wage gap index coefficient increases from .19 to 6.3, while for the gender wage gap under pure discrimination, on the fixed age level, the comparative advantage shifted from male group to female group, and on the fixed education level, the comparative advantage of male group shifted to female group in a larger degree.

In the finance, insurance and real estate industry, the gender wage gap had an obvious shift according to the change of intercept dummy variable coefficient from -1.9 to 8.4, implying that the comparative advantage for male group had increased by a large scale. However, according to the coefficients of slope dummy variables, on the fixed age and education level, the comparative advantage for male group of returning rate to wage had shifted to the female group. The increase of coefficient of education means the increase in returning rate of education to wage, implying the wage structure shifted to the higher educated group.

According to the regression result of business and repair service, the returning rate of age had decreased from 1985 to 1995, though the result is not significant in 1995. Other than the partial impact of age on wage, the results indicates a decrease of the returning rate of education to wage from 1985 to 1995, still having the result of 1995 insignificant. The significant result shown in the comparison is that, the gender wage gap has been increased from 0.48 to 3.79 at a significance level of 10%. The constant term also has a significance level of 1%, indicating an increase of the wage level from 5.60 in 1985 to 8.74 in 1995.

From the regression result of personal service industry, an increase of the returning rate of age at significance level of 1% has been detected, while the scale increase from 0.15 to 0.21. The comparative advantage of female group dramatically shifted to the male group from 1985 to 1995, while looking at the fixed education level, the comparative advantage of male group actually shifted to the female group in an opposite direction. In contradiction, with fixed age level, the comparative advantage of male continued increasing from .013 in 1985 to .026 in 1995.

In the entertainment and recreation service industry, the regression results have few coefficients significant because of the lack of the sample population. The sample population in 1985 for the entertainment and recreation service is 77 while this of 1995 is only 139. The results from table indicates a dramatically shift of the comparative advantage from female group to male group from 1985 to 1995. The gender difference of the returning rate of age on wage increased while the gender difference of the rerunning rate of education on wage also increased from 0.10 to 0.13.

Looking at the regression results of professional and related service industry, the returning rate of age and education to wage are all at significance level of 1% and 2%, while the result of

gender wage gap in 1995 is significant at level of 1% and the gender wage gap in 1985 is not significant enough. The coefficients indicate a decrease of the returning rate of age to wage and also a decrease for the returning rate of education to wage. The gender wage gap increases from 0.48 to 2.90 from 1985 to 1995.

Last, for the public administration industry, the result of age and marriage are significant. The returning rate of age to wage had decrease from 0.12 in 1985 to 0.09 in 1995 by a small scale. The gender wage gap in 1985 is represented in scale of 0.37, while this coefficient decreases to 0.12 in 1995 regression. However, the gender wage gap change is not clear due to the insignificant results.

Besides measuring the trend of the gender wage gaps in twelve industries, the comparison of trends of the gender wage gaps between industries gives a framework of the industrial level. The insignificant results shown in the table are not expected, while there are still several significant results which are expected from the model.

VI – Conclusion

In this research, the technical development was another key factor accompanied to trade liberalization, which caused the demand of labor shifted to higher education level. Part of the impact from technical development has been shown through measuring the change of partial impact of education on individual wage level, while the increase or the decrease of the returning rate of education to wage of the whole sample population implies the tendency of labor demand of skilled and unskilled worker. However, the impact of technical development has not been discussed comprehensively in this case, which may influence the results' accuracy. At present the conclusion can only be drawn from the labor structure shifts caused by trade liberalization.

Considering the industrial shift and the uneven job growth distribution reported in the literature reviewed previously, from 1979 to 1989, the mining and manufacturing industries lost large quantity of labor, while other industries all had an increase employment rate. The job growth rate in industries such as service and finance are reported to be the highest among all the industries. A large increase of the job growth rate also took place in the retail trade industry. While the job growth rate of fields such as government and transportation and public utilities kept at a steady speed. The wholesale trade and construction industries had a middle job growth speed comparing to other industries (Lois M. Plunkert, 1990).

Combining the industrial shift reports reviewed in the previous content with the empirical results of the gender wage gaps of different industries, the similar trends are observed. From the significant results, the gender wage gaps had changed more significantly in the industries of Agriculture, Forestry, and Fisheries; Manufacturing; Transportations, Communications, and Other Public Utilities; Wholesale and Retail Trade, Finance, Insurance, and Real Estate; and Professional and Related Service, except Mining industry is failed to measure its gender wage gap because of the lack of female individuals in the sample population. Most of these industries are labor intensive and according to the report of Lois M. Plunkert in 1990, most of the industrial shifts took place inside the serving, manufacturing, retail and wholesale industries. It is implied that when the industry was more trade related, under the trade liberalization, the labor structure inside the industry receive the import and export impact more sensitively than other industries. While the overall labor structure shifted more dramatically, the gender discrimination was more significant observed.

VI – Tables of Regressions

Agriculture, Forestry, and Fisheries		
Year	1985	1995
age	.1558013 * * * *	-.1789821 *
agesq	-.0009497 * * *	.0033004 * * * *
edu	.0103492	.4648939 * *
child	.0080506	.5745839 * * * *
marriage	-.206	2.770603 * * * *
sex	3.036516	11.80083 * * * *
age*sex	-.0661577 * * *	-.1219801 * * *
edu*sex	.0631082	-.8024376 * * * *
_cons	3.224134	6.374563
R ²	0.0982	0.3361
N	242	400

Mining		
Year	1985	1995
age	.0551448	2.129104
agesq	-.0006713	.0009997
edu	.0998277 * * * *	-4.209492 *
child	.0446837	-.3803688

marriage	.3511603	1.564576
sex	0 (omitted)	0 (omitted)
age*sex	.0091904	-2.260809
edu*sex	0 (omitted)	3.969457
_cons	7.194913 * * * *	17.51411 * * * *
R^2	0.2368	0.1140
N	112	114

Construction		
Year	1985	1995
age	.0979489 * * * *	-.0188447
agesq	-.0010609 * * * *	-.0005542
edu	.3428296 *	.2723615
child	.0066779	.2854708 * * * *
marriage	.1373945	.7609502 * * * *
sex	4.28844	4.170594
age*sex	-.0062787	.0675822
edu*sex	-.2933183	-.4567174 *
_cons	2.785857	7.266211 *
R^2	0.0636	0.0868
N	747	1151

Manufacturing		
Year	1985	1995
age	.1212731 * * * *	.0211601
agesq	-.0014056 * * * *	.000728 * *
edu	.0933413 * * * *	-.244822 * * * *
child	-.0172291 * * *	.1819365 * * * *
marriage	.1013647	.1048323
sex	.2868126	2.173342 * * *
age*sex	.009788 * *	-.0607306 * * * *
edu*sex	.009788	.0344523
_cons	5.841093 * * * *	11.87923 * * * *
R^2	0.2264	0.0881
N	2531	3089

Transportations, Communications, and Other Public Utilities		
Year	1985	1995
age	.1349993 * * * *	-.0762601
agesq	-.0016299 * * * *	.0010753 * *
edu	.043361	-.2517865 * * * *
child	-.026522	.244692 * * * *
marriage	.2484094 * * * *	.3527912

sex	-.6254378	-4.523257 * * * *
age*sex	.0098974	.0279777
edu*sex	.0428259	.2629076 * * * *
_cons	6.41343 * * * *	15.17508 * * * *
R^2	0.2492	0.0496
N	957	1261

Wholesale and Retail Trade		
Year	1985	1995
age	.1675747 * * * *	-.040225
agesq	-.0019959 * * * *	.0007683 * * * *
edu	.0721377 * * *	.0955604
child	-.0625295 * * * *	.034
marriage	.2797162 * * * *	.4265161 * * * *
sex	.1933426	6.302695 * * * *
age*sex	.0100222 * *	-.0198215
edu*sex	.005001	-.3545942 * * * *
_cons	4.822401 * * * *	8.978096 * * * *
R^2	0.3056	0.0998
N	1450	2276

Finance, Insurance, and Real Estate		
Year	1985	1995
age	.1985784 * * * *	-.0153124
agesq	-.0027469 * * * *	.0006524
edu	.0408244	.2605831 * * * *
child	-.0088664	.192165 * *
marriage	.1006969	.3483652
sex	-1.922535 * * * *	8.40931 * * * *
age*sex	.0424523 * * * *	-.0473152 * *
edu*sex	.0670294	-.447895 * * * *
_cons	5.521504 * * * *	6.379986 * * * *
R ²	0.4486	0.0796
N	328	593

Business and Repair Services		
Year	1985	1995
age	.0999359 * * * *	.0180935
agesq	-.0013312 * * * *	.0001565
edu	.1173624 * * * *	.0256265
child	-.0256841	.0124933
marriage	.3331161 * * * *	.2931818
sex	.4766709 *	3.788777*

age*sex	.0108343	-.0078748
edu*sex	-.0181737	-.1754264
_cons	5.559673 * * * *	8.737382 * * * *
R^2	0.3189	0.0660
N	439	794

Personal Service		
Year	1985	1995
age	.1498035 * * * *	.205862 * * * *
agesq	-.0018968 * * * *	-.0025373 * * * *
edu	.0633207 *	-.0955164
child	-.0853795	-.0877054
marriage	-.182063	2.106475 * * * *
sex	-.7212082	.7883463
age*sex	.0134882	.0258384
edu*sex	.10902 * *	-.1231636
_cons	4.962788 * * * *	7.185547 * * * *
R^2	0.3387	0.1846
N	342	410

Entertainment and Recreation Service

Year	1985	1995
age	0.949557	-.1210861
agesq	-.0006578	.0006322
edu	.094954	.1336336
child	.1871284 *	.1502525
marriage	-.6432403 **	.5043848
sex	-.3792329	.9007752
age*sex	-.0194784	.0851374
edu*sex	.032093	-.2572536
_cons	5.533798 ***	11.74378 ***
R^2	0.4339	0.0902
N	77	139

Professional and Related Service		
Year	1985	1995
age	.1678641 ****	.0741581 ****
agesq	-.0019045 ****	-.0007189 ****
edu	.1124666 ****	.0859665 ****
child	-.0403078 **	-.0182097
marriage	.1193837 **	.1171694
sex	.4845091	2.897545 ****

age*sex	.0028926	.0043012
edu*sex	-.0129166	-.1777665 * * * *
_cons	4.394877 * * * *	7.512503 * * * *
R^2	0.3477	0.0488
N	1357	2249

Public Administration		
Year	1985	1995
Age	.1236213 * * * *	.0906203 *
Agesq	-.0013712 * * * *	-.0012956 * * * *
Edu	.1170476 * * * *	.0694623
Child	.0054104	.0967025
marriage	.1986472 * * *	.4612691 * *
Sex	.3717893	.1227128
age*sex	.0031996	.034691 *
edu*sex	-.0287181	-.1062809
_cons	5.510791 * * * *	8.069397 * * * *
R^2	0.2164	0.0401
N	786	1143

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