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Changing wages and employment by skill in Taiwan, 1978-1996: The roles of education policy, trade, and immigration

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Changing wages and employment by skill in Taiwan, 1978-1996: The roles of education policy, trade, and immigration

by

Chun-Hung Andy Lin

A dissertation submitted to the graduate faculty

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ABSTRACT

Since the 1970s, Taiwan's labor market has been characterized as a smooth functioning, highly integrated and nearly full employment market, which also enjoying high growth in labor earnings. Unlike most developed countries, the average unemployment rate in Taiwan was under 3 percent over the 1978-1996 period. Unskilled labor shortage problem has forced many industrial companies to move abroad where have cheaper labor costs. In 1990, the government began to invite foreign temporary unskilled workers from the Philippines, Thailand, Malaysia, and Indonesia. Most foreign workers are in manufacturing and construction industries. About the same time, the Taiwan government also has been implementing several major educational reform policies. One policy was to increase the number of two-year and four-year colleges, causing the number of college graduates to increase dramatically since 1990.

In this study, the impacts of these two labor supply shocks, i.e., foreign unskilled labor and local skilled labor, on the Taiwan labor market are examined using the 1978-1996 "Survey of Family Income and Expenditure" in Taiwan. The effects of Taiwan's international trade on the relative labor demand shifts are also analyzed. We find there is little effect of imported foreign unskilled workers on employment and wages for both local skilled and unskilled workers. In the long run, foreign unskilled workers tend to be complements for both local skilled and unskilled workers. The increase in number of college graduates has, not surprisingly, reduced the returns to education for the young college graduates. Women's share in every industry has been dramatically increased and the gender earnings gap in Taiwan was significantly reduced during this period, although wage differentials against women still persist. The lower-educated workers and women were

favored in the prediction from the trade effect. However, the trend has been gradually shifted to the higher-educated workers.

CHAPTER 1

INTRODUCTION

Since the 1970s, Taiwan's labor market has been characterized as a smooth functioning, highly integrated and nearly full employment market, which also enjoys high growth in labor earnings (Fields and Wan (1989)). Unemployment has been very low compared to other industrialized economies. The average unemployment rate was under 3 percent for the 1978-1996 period. While most developed countries experienced varying degrees of unemployment, Taiwan had the opposite problem. According to the survey of Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan, Taiwan in 1987, more than two-third of Taiwanese manufacturing and construction companies had labor shortages, mainly in low-skilled labor. Wage pressure and labor shortages led many companies to move abroad, mainly China, to access lower paid foreign workers. In 1990, the Taiwan government began to invite foreign temporary contract labor from the Philippines, Thailand, Malaysia, and Indonesia. The timing of the invitation was related to a sharp currency appreciation which forced Taiwanese firms to find other means to lower their unit costs. By 1996, there were 210,000 legal and documented foreign workers and about 40,000 illegal foreign workers in Taiwan (Figure 1.1).

Most foreign workers are in manufacturing industries. A smaller percentage is engaged in governmental construction projects to develop Taiwan's infrastructure and still others serve in private homes as nurses or domestic helpers. The percentages of foreign workers in sectors are shown in the Appendix A. The supply of foreign labor to Taiwan is

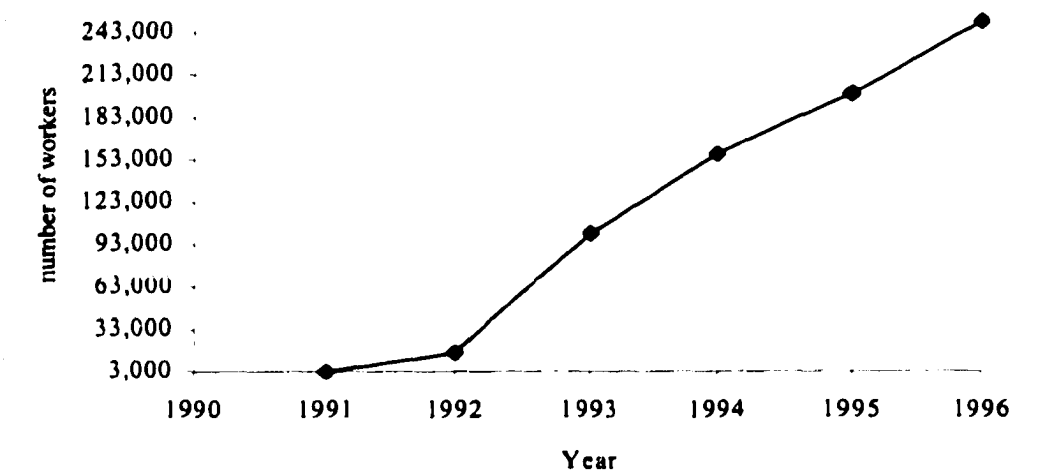

Figure 1.1: Total number of foreign workers, 1990-1996

limited by the Taiwan government and is usually less than the demand from local industrial companies. Given the excess demand, the government decides how many workers to allocate to each of these companies. Even though demand is much larger than the supply of unskilled labor according to the results of firm-level survey by DGBAS (1996), local companies still pay foreign workers at or near the minimum wage. According to the Council of Labor Affair's survey, the average wage for foreign workers in manufacturing and construction industries was about 20,000 N.T.$ per month, compared to 32,000 N.T.$ for domestic unskilled workers.

The influx of foreign unskilled labor could have several effects on the Taiwan labor market. The most popular argument has been that they will take jobs away from local workers and therefore increase the domestic unemployment rate and decrease domestic earnings.

Table 1.1 University Exam Passing Rate and Number of College Graduates, 1986-1997

Year	University Exam Passing Rate	Number of College Graduates*
1986	30.7%	99,838
1987	32.8%	102,242
1988	33.8%	105,676
1989	34.3%	114,313
1990	37.3%	129,193
1991	40.1%	144,354
1992	43.8%	156,600
1993	43.9%	172,849
1994	44.4%	181,621
1995	44.3%	189,517
1996	49.2%	196,384
1997	60.2%	215,412

Source: ministry of Education, Taiwan (1998).
*: include junior colleges, four-year colleges and graduate schools.

The Taiwan government has been also implementing several major education reform policies since 1990. One policy was to increase the number of two-year and four-year colleges. At the same time, the university entrance exam passing rate increased from 30.7 percent in 1986 to 49.2 percent in 1996, causing the number of college graduates to increase from 99,838 in 1986 to 196,384 in 1996 (Table 1.1).

As a result, the educational attainment of the population significantly improved (Table 1.2). The proportion of those with no formal education and those attending only primary school was reduced from 58.3 percent in 1978 to 30.7 percent in 1996, while the proportion of those with at least 2-year college degree increased from 8 percent in 1978 to 19.2 percent in 1996. Over the same period, based on the March Current Population Survey (CPS) data of U.S. Bureau of the Census, the proportion of those with no formal education

Table 1.2. Educational Attainment of Population Aged 15 Years and Older (%) in Taiwan

Year	Illiterate & Self-educated	Primary school	Junior high	Senior high	Junior college	Univ. &above
1978	18.5	39.8	15.2	18.4	3.8	4.2
1979	17.6	38.7	15.8	19.4	3.9	4.5
1980	16.5	37.0	16.0	21.0	4.6	5.0
1981	16.0	36.1	16.6	21.6	4.8	5.0
1982	15.3	35.3	16.6	22.7	5.0	5.0
1983	15.0	34.1	16.7	23.7	5.3	5.2
1984	14.4	33.1	17.0	24.5	5.6	5.4
1985	14.0	32.1	17.3	25.3	5.9	5.4
1986	13.5	31.0	17.4	26.3	6.1	5.7
1987	12.7	30.2	17.4	27.2	6.5	6.0
1988	11.8	29.6	17.4	28.1	6.9	6.3
1989	11.2	28.8	17.5	28.8	7.3	6.5
1990	10.5	27.8	17.6	29.5	7.8	6.9
1991	9.9	27.5	17.9	29.9	8.0	6.8
1992	9.4	26.3	18.0	30.6	8.6	7.2
1993	9.0	25.1	17.7	31.4	9.1	7.8
1994	8.8	24.4	17.8	31.8	9.4	7.9
1995	8.5	23.7	17.7	32.1	9.7	8.3
1996	8.1	22.6	17.3	32.8	10.4	8.8
1997	8.0	21.8	17.5	32.5	10.9	9.4

Source: DGBAS (1998), Executive Yuan, Taiwan.

and those attending only primary school for the United States was reduced from 19.3 percent in 1978 to 8 percent in 1996, while the proportion of those with at least 2-year college degree increased from 29.8 percent in 1978 to 48.1 percent in 1996. The rates of decrease for low-skill labor for Taiwan and the U.S. were nearly equal, both falling by about 50 percent. But the speed of increasing high-skilled labor for Taiwan is faster than that for the U.S. during this period.

The increase in relative supply of more skilled labor should lower the returns to education and reduce earnings inequality, if relative labor demand is held constant.

Certainly, demand plays an important role in determining the relative employment level and wage gap between groups (Katz and Murphy (1992)).

In this dissertation, the impacts of these two supply shocks, i.e., foreign unskilled labor and local skilled labor, on the Taiwanese labor market are examined. The case of Taiwan is of interest in that many NIEs (Newly Industrialized Economies), such as South Korea, Singapore and Hong Kong are facing the same issues. They all have experienced high economic growth and increased investment in education for the past 20 years, and now continued tightness in labor market exists in all of these four economies. Fields (1994) showed that rapid economic growth led to improvements in labor market conditions, such as unemployment rates, job mix, and real earnings. Unemployment rates were declining dramatically and real incomes grew at least 60 percent during the 1980s in these countries. A larger share of workers came to be employed in professional, administrative and managerial, clerical, and sales occupations. These are all leading to the possibility of low-skilled labor shortage in future. Resolving the problem may involve reverting to high-skilled intensive production activities, importing a supply of low-skilled labor, or exporting capital to low-skilled intensive countries by moving production abroad. This study is organized as follows. Chapter 2 describes the data we use in this dissertation and analyzes the changes of employment level and wages by different aspects during the 1978-1996 period. Chapter 3 states the hypotheses needed to be tested and provides the theoretical framework to examine the changes in the Taiwan labor market observed in previous chapter. Chapter 4 investigates the effects of foreign workers on outcomes of Taiwan labor market. Chapter 5 will summarize and conclude the findings of this study.

CHAPTER 2

CHANGES IN RELATIVE EMPLOYMENT AND WAGES, 1978-1996

Data Sources

The main database used in this dissertation is taken from a time series of household surveys. Before 1994, the survey was called "Personal Income Distribution Survey". Since then, the name has been changed to "Survey of Family Income and Expenditure". The database is collected by the Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan, Taiwan. The questionnaire form of the survey is in the Appendix B of this dissertation. Most of the sample data are collected by random face-to-face interview, with some supplemental mail interviews. The data set contains household income, education level, working sector, age and gender. For this study, we will concentrate on the 1978, 1981, 1984, 1987, 1990, 1993, and 1996 editions of the survey. Although the survey data does not track individual households over time (i.e., it's not a panel data set), we still are able to establish the trend of average wages and employment levels by education, experience, industry and gender over the period of 1978-1996.

We will concentrate on the movement of wage, skill level and employment for workers who are employed in the private and public sectors. Self-employed and unemployed workers are excluded from our analysis. An average of 12,800 individuals aged 18-65 who are not in military service are contained in the data set each year. Also, we only include the primary wage and industry of the worker if the worker has multiple jobs. The primary wage in this data set does not include the nonwage compensation, such as health insurance, pension and other fringe benefits from employers, but it does include the annual bonus from

employers. The annual bonus is a very common element of compensation in the Taiwan labor market. It is typically paid to workers at the end of the year. Consequently, it is appropriate to incorporate the annual bonus when calculating workers' average annual wages.

Although the data set in the paper is survey data, it is very close to the macro data published in the Yearbook of Earnings and Productivity Statistics by DGBAS[1]. In Table 2.1, average monthly wages reported from DGBAS are the total average wages made by a worker. They are higher than the average wages in the survey data because we only calculate the average wages for the workers' primary job. Most of the numbers in Table 2.1 are close to the DGBAS's values, although some of them might be a little different due to the sampling method and sample size. We still can see the trends of the distribution of workers by education and industry are quite close to the DGBAS data. Male-female ratios of employed workers are also very close in trend and magnitude across the two data sets. Therefore, the findings in the dissertation should reflect the true changes of employment and wages in the Taiwan labor market.

Changes in Relative Employment

Taiwan's economy has done very well in generating employment opportunities since the 1960's. The average unemployment rate has been below 3 percent each year and near full-employment has been maintained. The labor shortage in the late 1980's opened up opportunities for foreign low-skilled contract labor, but also increased opportunities for local Taiwanese women. Women's labor force participation rate has been rising from 39.1 percent

[1] The source and survey method of macro data are described in the appendix to the Yearbook.

Table 2.1. Comparison between DGBAS Macro Data and Survey Micro Data, 1978-1996

	Average Monthly Wage (N.T.$)		Distribution of Workers by Education									
			Univ.&above		Junior College		Senior High		Junior High		Primary&below	
Year	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey
1978	N.A.	14,740	4.26%	10.24%	4.26%	8.84%	16.71%	23.90%	17.35%	13.96%	57.43%	43.06%
1981	15,344	15,973	5.25%	9.41%	5.63%	9.02%	20.35%	24.68%	19.20%	14.85%	49.58%	42.04%
1984	18,460	18,526	5.65%	9.37%	6.42%	10.08%	23.41%	26.52%	19.47%	15.03%	45.06%	39.01%
1987	22,506	20,838	6.17%	8.61%	7.65%	10.73%	26.60%	27.18%	19.82%	16.44%	39.76%	37.05%
1990	30,180	26,998	7.19%	10.17%	9.15%	11.93%	29.86%	30.24%	19.90%	16.61%	33.89%	31.05%
1993	35,285	32,360	8.05%	11.19%	10.91%	13.62%	32.27%	31.93%	20.00%	16.17%	28.77%	27.08%
1996	36,810	33,638	9.46%	13.32%	12.81%	15.36%	34.14%	33.59%	19.40%	15.87%	24.19%	21.85%

	Distribution of Workers by Industry											
	Ag,Mining&Quarrying		Manufacturing		Electricity		Construction		Commerce		Transportation	
Year	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey	DGBAS	Survey
1978	25.9%	9.9%	30.7%	34.0%	0.4%	1.7%	7.4%	10.2%	15.1%	7.3%	4.9%	9.8%
1981	19.7%	10.8%	32.4%	35.3%	0.4%	1.5%	8.7%	10.6%	16.6%	7.9%	5.1%	8.3%
1984	18.2%	6.8%	34.2%	39.2%	0.5%	1.5%	7.1%	11.4%	17.5%	8.5%	5.1%	6.9%
1987	15.7%	6.2%	35.2%	41.6%	0.4%	1.3%	6.8%	11.6%	17.8%	8.9%	5.1%	6.4%
1990	13.1%	5.0%	32.0%	37.6%	0.4%	1.4%	8.1%	12.2%	19.6%	11.1%	5.3%	6.5%
1993	11.7%	3.8%	28.4%	33.1%	0.4%	1.1%	10.1%	15.2%	20.7%	11.7%	5.3%	6.1%
1996	10.3%	2.4%	26.7%	32.4%	0.4%	1.3%	10.2%	13.3%	21.8%	17.7%	5.2%	6.5%

	F.I.R.E.		Social Services	
Year	DGBAS	Survey	DGBAS	Survey
1978	2.0%	3.2%	13.7%	24.0%
1981	2.5%	3.1%	14.6%	22.4%
1984	2.7%	3.5%	14.9%	22.1%
1987	3.0%	3.2%	15.9%	21.0%
1990	4.5%	5.1%	17.0%	21.2%
1993	5.5%	6.3%	18.0%	22.8%
1996	6.2%	7.1%	19.1%	23.1%

Gender Ratio	
DGBAS	Survey
2.04	2.80
2.00	2.29
1.76	2.12
1.62	1.94
1.66	1.77
1.63	1.65
1.55	1.46

Sample size
11,550
12,905
13,428
13,408
13,402
13,835
11,182

in 1978 to 45.8 percent in 1996, while male labor force participation rate has fallen from 78.0 percent in 1978 to 71.1 percent in 1996.

Taiwan began to import low-skilled contract labor from Thailand, Indonesia, Philippines and Malaysia in 1991. There were more than 250,000 foreign temporary workers, including illegal immigrants, in Taiwan in 1996. Most of them are low-skilled and concentrated in the manufacturing, construction and social and personal services sectors.

Also in 1991, the Taiwanese central government started several major educational reforms. The relaxation of the restrictions on establishing new universities and colleges has caused the number of new two-year and four-year college graduates to rise.

These two labor supply shocks have persisted and grown in magnitude every year and would be expected to cause structural changes on relative employment and wages. The changes in employment will be discussed next from the perspectives of industry, education, experience, and gender.

Employment by industry group

Table 2.2 shows the changes in employment by industry and worker's education level. The values in the first ten columns represent the ratios of 1990 employment relative to 1978 employment and 1996 employment relative to 1990 employment in the industry/education cell. The values in brackets are measured by employment growth of the educational group relative to employment growth in the industry as a whole, i.e., the industry/education cell ratio minus the ratio for the industry as a whole. The values in the last two columns are the employment growth for the respective industry from 1978 to 1990 and from 1990 to 1996. The values in brackets in the last two columns are measured by

Table 2.2. Relative Employment by Education Level and Industry, Taiwan, 1978-1996

	Primary&less		Junior high		Senior high	
Sector	78-90	90-96	78-90	90-96	78-90	90-96
Ag., Forestry, Fishery	0.53	0.45	1.22	0.64	0.97	0.99
Mining & Quarrying	(-0.09)	(-0.08)	(+0.60)	(+0.11)	(+0.35)	(+0.46)
Manufacturing	1.00	0.69	1.69	0.86	1.76	1.10
	(-0.35)	(-0.25)	(+0.34)	(-0.08)	(+0.41)	(+0.16)
Electricity, Gas&Water	0.57	0.38	0.81	1.31	1.07	1.02
	(-0.45)	(-0.63)	(-0.21)	(+0.30)	(+0.05)	(+0.01)
Construction	1.13	0.87	2.71	1.42	2.58	1.71
	(-0.35)	(-0.33)	(+1.23)	(+0.22)	(+1.10)	(+0.51)
Commerce	1.09	1.11	1.65	1.32	2.31	1.41
	(-0.79)	(-0.27)	(-0.23)	(-0.06)	(+0.43)	(+0.03)
Transportation, Storage	0.52	0.75	0.76	1.18	1.16	1.00
& Communication	(-0.30)	(-0.33)	(-0.06)	(+0.11)	(+0.34)	(-0.08)
F.I.R.E.	1.86	1.26	1.98	0.97	1.92	1.20
	(-0.06)	(-0.28)	(+0.06)	(-0.57)	(n.c.)	(-0.34)
Social, Personal Services	0.91	1.05	0.87	1.18	1.11	1.25
&Public Administration	(-0.17)	(-0.14)	(-0.21)	(-0.01)	(+0.03)	(+0.06)
All Sectors	0.89	0.77	1.46	1.05	1.56	1.22
	(-0.34)	(-0.32)	(+0.23)	(-0.04)	(+0.33)	(+0.13)

Note: The relative employment represents the ratios of 1990 employment relative to 1978 employment and 1996 employment relative to 1990 employment in the sector/ education cell.

Finance, Insurance and Real Estate (F.I.R.E.) sector includes industrial and commercial services.

Total numbers of sample in 1978, 1990, and 1996 are 11550, 13402, and 11182 respectively.

Table 2.2. (continued)

	Junior college		Univ.&above		All education levels	
Sector	78-90	90-96	78-90	90-96	78-90	90-96
Ag., Forestry, Fishery Mining & Quarrying	1.88 (+1.26)	0.77 (+0.24)	0.44 (-0.18)	0.79 (+0.26)	0.62 (-0.61)	0.53 (-0.56)
Manufacturing	2.23 (+0.88)	1.46 (+0.52)	1.05 (-0.30)	1.37 (+0.43)	1.35 (+0.12)	0.94[a] (-0.15)
Electricity, Gas&Water	1.73 (+0.71)	1.02 (+0.01)	1.01 (-0.01)	1.38 (+0.37)	1.02 (-0.21)	1.01 (-0.08)
Construction	1.82 (+0.34)	2.91 (+1.71)	1.43 (-0.05)	1.34 (+0.14)	1.48 (+0.25)	1.20[b] (+0.11)
Commerce	3.05 (+1.17)	1.49 (+0.11)	1.77 (-0.11)	1.56 (+0.18)	1.88 (+0.65)	1.38 (+0.29)
Transportation, Storage & Communication	1.39 (+0.57)	1.68 (+0.60)	0.84 (+0.02)	1.39 (+0.31)	0.82 (-0.41)	1.08 (-0.01)
F.I.R.E.	2.92 (+1.00)	2.01 (+0.47)	1.39 (-0.53)	2.17 (+0.63)	1.92 (+0.69)	1.54 (+0.45)
Social, Personal Services &Public Administration	1.16 (+0.08)	1.07 (-0.12)	1.25 (+0.17)	1.31 (+0.12)	1.08 (-0.15)	1.19[c] (+0.10)
All Sectors	1.66 (+0.43)	1.41 (+0.32)	1.23 (n.c.)	1.43 (+0.34)	1.23	1.09[d]

[a] Not include foreign workers. It becomes 0.98 if foreign workers are included.

[b] Not include foreign workers. It becomes 1.45 if foreign workers are included.

[c] Not include foreign workers. It becomes 1.26 if foreign workers are included.

[d] Not include foreign workers. It becomes 1.12 if foreign workers are included.

employment growth of the industry relative to the employment growth of the whole Taiwan labor market.

From Table 2.2 we can see the major industries which lost employment throughout the entire 1978-1996 period are agriculture, forestry, fishery, mining and quarrying. Manufacturing industry gained 35% between 1978 and 1990, but lost 6% in the 1990-1996 period. If foreign workers are included, it still lost 2% in this period. Electricity, gas and water industry had a minor gain for both periods, but lost relative to the labor market growth as a whole. Construction, commerce, and especially finance, insurance, and real estate (F.I.R.E.) industries have substantial employment gains in the entire 1978-1996 period. Services sector had a slower growth in 1978-1990 relative to the labor market as a whole, but faster in 1990-1996.

The rising real wage in the experience of Taiwan high economic growth has been causing those labor-intensive industries to lose competitive advantages in their markets. The increase in land cost and imports of cheaper agricultural products forced farmers to redirect their land toward business and industrial usage. Beginning in the early 1990's, the Taiwan government also gradually released the barriers for Taiwanese manufacturing companies to invest in China and other Southeast Asia countries. Although foreign low-skilled workers started coming to Taiwan labor market, the quotas never reached the demand from those enterprises which suffered labor shortage. And also, the wage for these imported foreign unskilled workers in Taiwan was still much higher than it was in their home countries even most of them were only paid minimum wage in Taiwan. Many Taiwanese manufacturing companies, especially in textile and garment industry, started shifting their factories to these countries to take advantages of low labor and fixed costs. Most of them were located in

China for the managerial reason because both Chinese workers and Taiwanese managers can speak the same language.

Based on the results from Table 2.2, we did not observe that construction and services sectors which also imported foreign unskilled workers suffered decrease in relative employment. Instead, the employment rose about 10 percent relative to the labor market as a whole during 1990-1996. By contrast, even we include the jobs filled by foreign workers in manufacturing industry, the relative employment still lost by 2 percent in this period. Obviously foreign workers can't be the major reason of losing employment in the manufacturing industry.

On the other hand, according to DGBAS statistics (1997), the share of employed workers in commerce, F.I.R.E., and services sectors has increased from 27.4 percent in 1978 to 43.6 percent in 1996. This suggests that some of the workers in agriculture, mining and quarrying, and manufacturing have moved to these three industries due to the reduced demand for labor in their original sectors.

Employment by education group

Again from Table 2.2, we can see that employment decreased substantially for those with only primary or less degree in these two periods, 11% in 1978-1990 and 23% in 1990-1996, while at the same time it rose 66% and 41%, and 23% and 43% for those with junior college and at least university degrees respectively. The employment for junior high and senior high also rose in most of industries, except agriculture, mining and quarrying, although overall increase is less for junior high (46% in 1978-1990, 5% in 1990-1996) than it for senior high (56% in 1978-1990, 22% in 1990-1996).

The employment for those with primary or less degree didn't fall in every industry. In commerce and F.I.R.E. industries, it gained some employment in both 1978-1990 and 1990-1996 periods, but still lost relative to their respective industries as a whole. It suggests that these two industries have absorbed some of the lower educated workers from agriculture, mining and quarrying, manufacturing, electricity, construction, and transportation industries.

It's clear that the relative employment for more educated workers has been rising since 1978 in every industry. Evidence from other country settings showed that technological change in favor of more educated workers could cause this employment redistribution (Appelbaum and Schettkat (1990), Berman, Bound, and Griliches (1994), Autor, Katz, and Krueger (1998)). The changes in production function technology increase the relative demand for more educated workers. This is consistent with Taiwan's skill and industrial labor market structures during the entire 1978-1996 period. Table 2.3 shows the distributions of local workers by industry and education in 1978, 1990, and 1996. The educational expansion increases the percentage of more educated workers and reduces the percentage of less educated workers in every industry. Except for construction, industries which are relatively more low-skilled intensive are also the industries losing employment. Those industries which are relatively more high-skilled intensive are the industries gaining employment during this period. The reason the construction industry gained employment during this period is the increasing amount of government investment in infrastructure. The Six-Year National Development Plan, initiated in 1991, was a major government policy designed to boost personal income, strengthen the development potential of local industries, balance regional development, and enhance the quality of life (The Republic of China

Table 2.3 Distribution of Employment (%) by Education Level and Industry, Taiwan, 1978-1996

	Primary&less			Junior high			Senior high			Junior college			Univ.&above		
Sector	1978	1990	1996	1978	1990	1996	1978	1990	1996	1978	1990	1996	1978	1990	1996
Ag.,Forestry,Fishery &Mining,Quarrying	84.6	73.0	61.1	7.7	15.2	18.2	6.1	9.2	17.0	0.6	1.8	2.6	1.1	0.8	1.1
Manufacturing	48.9	36.1	26.6	17.3	21.5	19.6	23.2	29.9	35.1	4.9	8.1	12.4	5.7	4.4	6.4
Electricity, Gas&Water	20.5	11.5	4.3	11.1	8.7	11.4	44.2	46.5	46.8	13.2	22.4	22.7	11.1	10.9	14.9
Construction	73.8	56.9	41.4	11.9	21.7	25.7	8.6	15.1	21.5	2.7	3.4	8.2	3.0	2.9	3.2
Commerce	28.0	16.3	13.2	16.3	14.3	13.7	35.3	43.4	44.6	9.9	16.0	17.3	10.6	10.0	11.3
Transportation,Storage &Communication	38.7	24.4	16.9	18.1	16.8	18.5	27.5	38.7	35.8	6.3	10.6	16.5	9.4	10.0	12.3
Finance, Insurance &Real Estate	4.3	4.1	3.4	7.8	8.0	5.0	47.6	47.6	37.1	13.9	21.1	27.5	26.5	19.2	27.0
Social,Personal services &Public Administration	17.9	15.0	13.2	11.4	9.1	9.0	29.2	29.7	31.1	20.1	21.5	19.3	21.5	24.8	27.3

Source: DGBAS, Executive Yuan, Taiwan (1997).

Yearbook, 1995). It included projects in transportation, urban development, air and water pollution, telecommunication, and cultural, medical, and recreational facilities.

From the log-wage regression result in Table 2.9 later in this chapter, we can see the rates of return to education are fairly constant at every educational level from 1990 to 1996. Meanwhile, government's educational reforms have caused the number of junior college and university graduates increased dramatically during the 1990-1996 period. In order to keep returns to education constant, the relative demand for more educated workers must have increased during this period.

Employment by experience group

Table 2.4 shows the changes in relative employment by experience and industry over the 1978-1996 period. Almost all of the experience groups gained employment during this period, especially for the young workers (with no more than 5 years of experience). During 1990-1996, relative employment for those with over 40 years of experience fell by 6%, declining 15% relative to overall employment. Relative employment for the workers who just got out of school (the least experienced or youngest) rose 17%, 8% faster than the overall employment growth. More junior college and university graduates entered the job market every year. Employment increased 81% for those with at least junior college education and no more than 5 years of experience during 1990-1996 (See Table 2.5), compared to an 8% increase during 1978-1990. Most of these new graduates went to manufacturing and service industries, but the employment shares in these two industries declined during 1990-1996. On the other hand, the employment share for F.I.R.E. gained 167% relative to the overall

Table 2.4. Relative Employment by Working Experience and Industry, Taiwan, 1978-1996

	0-5 years		6-10 years		11-20 years	
Sector	78-90	90-96	78-90	90-96	78-90	90-96
Ag., Forestry, Fishery	0.37	0.26	0.31	0.76	0.52	0.47
Mining & Quarrying	(-0.25)	(-0.27)	(-0.31)	(+0.23)	(-0.10)	(-0.06)
Manufacturing	1.20	0.80	1.15	0.79	1.41	0.88
	(-0.15)	(-0.14)	(-0.20)	(-0.15)	(+0.06)	(-0.06)
Electricity, Gas&Water	0.30	2.62	0.38	0.84	1.50	0.55
	(-0.72)	(+1.61)	(-0.64)	(-0.17)	(+0.48)	(-0.46)
Construction	0.78	2.12	1.73	1.34	1.19	1.20
	(-0.70)	(+0.92)	(+0.25)	(+0.14)	(-0.29)	(n.c.)
Commerce	1.95	1.19	1.69	1.19	2.20	1.24
	(+0.07)	(-0.19)	(-0.19)	(-0.19)	(+0.32)	(-0.14)
Transportation, Storage	0.95	1.18	0.56	1.18	0.96	0.90
& Communication	(+0.13)	(+0.10)	(-0.26)	(+0.10)	(+0.14)	(-0.18)
F.I.R.E.	1.40	1.41	1.64	1.41	2.27	1.44
	(-0.52)	(-0.13)	(-0.28)	(-0.13)	(+0.35)	(-0.10)
Social, Personal Services	1.40	1.01	1.13	1.01	1.26	1.13
&Public Administration	(+0.32)	(-0.18)	(+0.05)	(-0.18)	(+0.18)	(-0.06)
All Sectors	1.27	1.17	1.17	1.01	1.33	1.03
	(+0.04)	(+0.08)	(-0.06)	(-0.08)	(+0.10)	(-0.06)

Note: The relative employment represents the ratios of 1990 employment relative to 1978 employment and 1996 employment relative to 1990 employment in the sector/ education cell.

Finance, Insurance and Real Estate (F.I.R.E.) sector includes industrial and commercial services.

Total numbers of sample in 1978, 1990, and 1996 are 11550, 13402, and 11182 respectively.

Table 2.4. (continued)

	21-30 years		31-40 years		40+ years		Total	
Sector	78-90	90-96	78-90	90-96	78-90	90-96	78-90	90-96
Ag., Forestry, Fishery	0.54	0.46	0.59	0.55	1.29	0.64	0.62	0.53
Mining & Quarrying	(-0.08)	(-0.07)	(-0.03)	(+0.02)	(+0.67)	(+0.11)	(-0.61)	(-0.56)
Manufacturing	1.43	1.09	1.31	1.06	1.86	0.96	1.35	0.94
	(+0.08)	(+0.15)	(-0.04)	(+0.12)	(+0.51)	(+0.02)	(+0.12)	(-0.15)
Electricity, Gas&Water	0.87	1.68	0.94	1.37	3.36	0.83	1.02	1.01
	(-0.15)	(+0.67)	(-0.08)	(+0.36)	(+2.34)	(-0.18)	(-0.21)	(-0.08)
Construction	1.65	1.03	1.43	1.32	2.43	1.10	1.48	1.20
	(+0.17)	(-0.17)	(-0.05)	(+0.12)	(+0.95)	(-0.10)	(-0.05)	(+0.11)
Commerce	2.06	1.78	1.41	1.79	1.18	1.23	1.88	1.38
	(+0.18)	(+0.40)	(-0.47)	(+0.41)	(-0.70)	(-0.15)	(+0.65)	(+0.29)
Transportation, Storage	0.89	1.21	0.59	1.28	1.09	0.92	0.82	1.08
& Communication	(+0.07)	(+0.13)	(-0.23)	(+0.20)	(+0.27)	(-0.16)	(-0.41)	(-0.01)
F.I.R.E.	2.33	1.98	1.80	1.01	1.74	1.26	1.92	1.54
	(+0.41)	(+0.44)	(-0.12)	(-0.53)	(-0.18)	(-0.28)	(+0.69)	(+0.45)
Social, Personal Services	0.98	1.46	0.73	1.19	1.54	0.91	1.08	1.19
&Public Administration	(-0.10)	(+0.27)	(-0.35)	(n.c.)	(+0.46)	(-0.28)	(-0.15)	(+0.10)
All Sectors	1.22	1.22	0.98	1.15	1.62	0.94	1.23	1.09
	(-0.01)	(+0.13)	(-0.25)	(+0.06)	(+0.39)	(-0.15)		

Table 2.5. Relative Employment Changes for Workers with at least Junior College Education and no more than 5 Years of Experience, Taiwan, 1978-1996

Sector	1978 share	1990 share	1996 share	78-90[a]	90-96[b]
Ag., Forestry, Fishery Mining & Quarrying	0.9%	~ 0%[c]	~ 0%[c]	n.a.	n.a.
Manufacturing	26.3%	31.3%	27.6%	1.29	1.59
Electricity, Gas&Water	0.6%	~ 0%[c]	~ 0%[c]	n.a.	n.a.
Construction	5.6%	3.4%	4.9%	0.65	2.62
Commerce	13.5%	17.2%	16.0%	1.38	1.69
Transportation, Storage & Communication	7.2%	4.6%	2.9%	0.69	1.14
F.I.R.E.	11.3%	8.9%	17.2%	0.85	3.48
Social, Personal Services &Public Administration	34.5%	34.7%	31.2%	1.09	1.63
All Sectors	100%	100%	100%	1.08	1.81

Source: Author's calculation.

[a] Relative employment of 1990 to1978.

[b] Relative employment of 1996 to 1990.

[c] No observation in the sample.

n.a. not available due to too few observations.

employment growth of the young educated workers. This suggests that more new 2-year or 4-year college graduates would like to choose finance-related job as their first job.

The patterns of change in relative employment by experience group differ greatly for men and women (Table 2.6). The employment share fell for young women but maintained little change for young men over 1978-1996 period. For men, the employment for those with 0-5 years of experience rose 19% and employment for those with more than 41 years of experience fell 16% during 1990-1996. By contrast, for women, the employment for those with more than 41 years of experience rose 41%, 25% more than the employment increase for the least experienced women. This gives us a clue that men might be retiring earlier than before, and women might be working longer than before.

And also, according to DGBAS statistics (1997), the labor force participation rate for workers aged 25-34 has increased from 68.9 percent in 1978 to 78.8 percent in 1996, while it decreased from 50.1 percent in 1978 to 47.5 percent in 1996 for workers aged more than 55. This may be due to better retirement pension and social welfare programs from government. Therefore, even though the Taiwan population has been aging since 1978 (see Appendix C), the relative employment for young workers rose and the relative employment for old workers fell.

Employment by gender

Changes in male-female employment during 1978-1996 are shown in Table 2.6. Relative employment for women increased 69%, 46% higher than the overall growth in employment during 1978-1990, and increased 23%, 14% higher than the overall growth in

Table 2.6. Relative Employment by Gender and Experience, Taiwan, 1978-1996

	1978 share		1990 share		1996 share		78-90[a]		90-96[b]	
Experience	men	women	men	women	men	women	men	women	men	Women
0-5 years	5.1%	15.9%	4.7%	14.6%	5.4%	13.7%	0.97	1.54	1.19	1.16
6-10 years	11.9%	21.3%	12.4%	15.8%	12.0%	13.4%	1.11	1.25	0.99	1.05
11-20 years	30.5%	24.8%	33.1%	28.4%	30.2%	28.5%	1.16	1.93	0.93	1.24
21-30 yaers	24.1%	23.4%	23.1%	24.7%	26.9%	25.9%	1.02	1.78	1.18	1.29
31-40 years	20.7%	11.9%	15.8%	12.4%	16.5%	13.8%	0.82	1.76	1.06	1.37
41+ years	7.8%	2.7%	10.9%	4.1%	9.0%	4.7%	1.51	2.57	0.84	1.41
Total	100%	100%	100%	100%	100%	100%	1.07	1.69	1.02	1.23

Source: Author's calculation.

[a] Relative employment of 1990 to 1978.

[b] Relative employment of 1996 to 1990.

employment during 1990-1996, while relative employment for men increased only 7% during 1978-1990, and 2% during 1990-1996, 16% and 7% lower than the overall employment growth in the respective periods. Women's overall employment share increased from 24.6% in 1978 to 40.7% in 1996 (Table 2.7). Among these increases in women's employment, women with at least a junior college degree gained 430%, while women with no more than primary schooling lost 24% employment during the 1978-1996 period.

Women's share increased in most sectors. The largest increases in women's employment shares were in commerce, F.I.R.E., and service sectors, which were also the fastest growing sectors in the economy. However, women's employment shares declined in agriculture, mining and electricity, gas and water during the 1978-1996 period. It suggests that changes in women's employment shares were positively correlated with the employment growth of individual sectors. In fact, women's employment shares in commerce, F.I.R.E. and service sectors were over 50% in 1996.

Changes in Wages

Alone with consistently high economic growth for the past 40 years, Taiwan has experienced rising real income. Real wages increased seven times from 1952 to 1987 (DGBAS) and earnings inequality decreased to the lowest level of any economy in the world (Fei, Ranis and Kuo (1979), Kuo (1983), and Fields (1984, 1985)). In this section we describe the changes in wages of 18-65 years old Taiwanese workers over the period of 1978 to 1996. From Figure 2.1, we can see average real wages have risen since 1978.

Table 2.7. Women Share (%) in Industry, Taiwan, 1978-1996

Sector	1978	1990	1996
Ag., Forestry, Fishery Mining & Quarrying	37.1	28.8	30.4
Manufacturing	29.4	40.8	41.2
Electricity, Gas&Water	14.2	14.8	13.5
Construction	7.9	12.9	15.7
Commerce	28.0	42.1	51.3
Transportation, Storage & Communication	11.1	16.0	19.8
F.I.R.E.	28.9	45.3	50.5
Social, Personal Services &Public Administration	31.6	45.1	53.1
All Sectors	26.4	36.1	40.7

Source: Author's calculation.

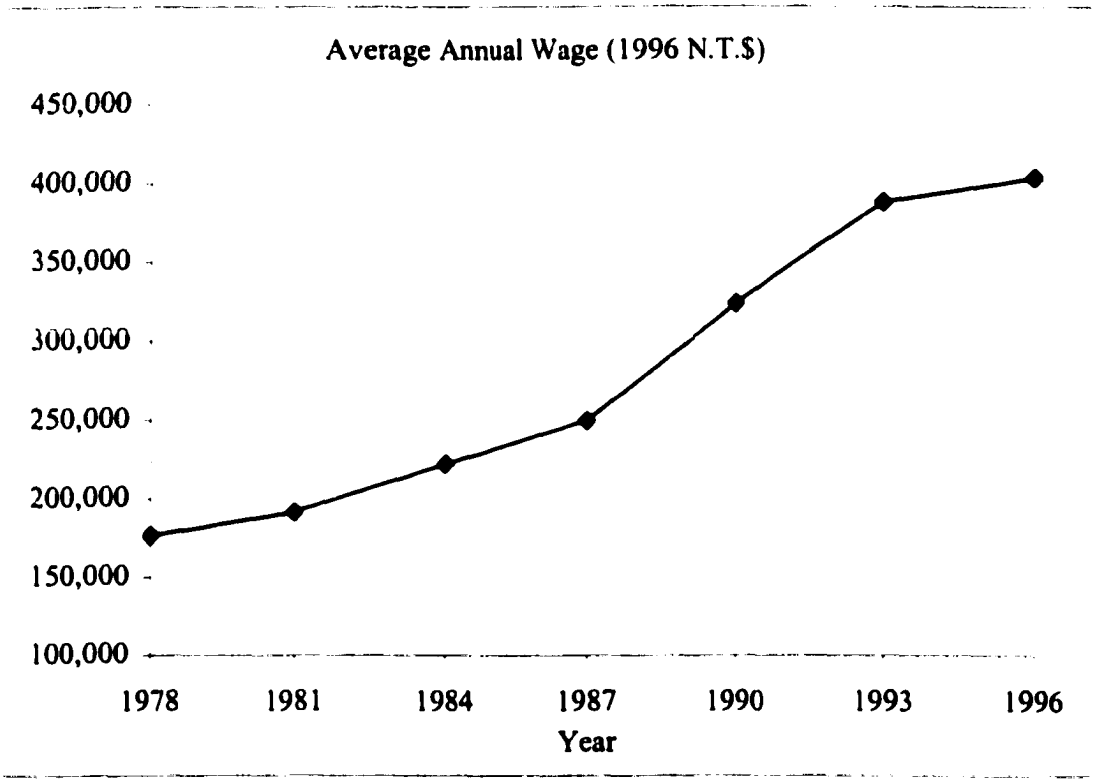

Figure 2.1. Average Annual Wage (1996 N.T.$)[2], Taiwan, 1978-1996

To investigate the changes in wages, we begin by setting up the wage equation (Mincer 1974) as

$$(2.1) \qquad lnW_{it} = \alpha_t + X_{it}\beta_t + M_{it}\phi_t + S_{it}\gamma_t + e_{it}$$

where i is the individual index, t is the year, and W is the annual wage. X is a vector of human capital measures. The human capital measures include dummy variables indicating

[2] The exchange rate between New Taiwan Dollar (N.T.$) and US$ was about 27.5 N.T.$ per US$ in 1996.

educational attainment and a measure of potential job experience (age – years of schooling – 6) and its square. The years of schooling for junior high, senior high, junior college, and university are 9, 12, 14, and 16 respectively. M is a dummy variable which takes the value of 1 if the individual is male. The vector S includes 1-digit industry dummy variables, and α, β, ϕ, and γ, are parameters and e is the error term. The variable definitions are described in Table 2.8. The sample statistics have been shown in Table 2.1.

The estimates of the log-wage equation (2.1) yield information on returns to education, experience, gender and industry. The coefficients on the education dummy variables are interpreted as the average additional rate of return to one education level relative to primary school graduates. The coefficients of experience and the square of experience yield a quadratic path of average additional rate of return to a year of experience. γ_i is interpreted as the average additional rate of return to one industry relative to agriculture, mining and quarrying industry. ϕ represents the wage differential between men and women, other things held constant.

We also estimate the log-wage equation for men and women separately (Table 2.10 and 2.11). From this we can see the patterns of estimates for men and women separately over the period of 1978-1996.

In the following section, we are going to look at several important aspects regarding the earnings of Taiwanese workers over this period. First, the changes of returns to education over time; second, the changes of returns to experience over time; third, female-male earnings gap; fourth: the changes in wage inequality between groups and within groups.

Table 2.8. Definition of Variables in Log-Wage Equation

Variable	Definition
JuniorHigh	equal 1 if the individual is a junior high school graduate, 0 otherwise
SeniorHigh	equal 1 if the individual is a senior high school graduate, 0 otherwise
JuniorCollege	equal 1 if the individual is a junior college graduate, 0 otherwise
Univ.&above	equal 1 if the individual is at least 4-year college graduate, 0 otherwise
Experience	equal (age - years of schooling - 6)
Experience^2	equal square of Experience
Male	equal 1 if gender of the individual is male, 0 otherwise
Manufacturing	equal 1 if the individual works in manufacturing, 0 otherwise
Electricity	equal 1 if the individual works in electricity, gas or water, 0 otherwise
Construction	equal 1 if the individual works in construction, 0 otherwise
Commerce	equal 1 if the individual works in commerce, 0 otherwise
Transportation	equal 1 if the individual works in transportation, 0 otherwise
F.I.R.E.	equal 1 if the individual works in finance, insurance or real estate, 0 otherwise
SocialService	equal 1 if the individual works in social services, 0 otherwise

Returns to education

There are many ways to measure the return to education. Gindling, Goldfarb and Chang (1995) used three distinct approaches to estimate returns to education for Taiwan during 1978-1991: (1) average earnings by educational level, (2) coefficients on the education dummy variables in log-wage equation, (3) the internal rate of return to education. They found that unlike most other developing countries[3], Taiwan had remarkably stable returns for all education levels during 1978-1991.

First, we examine the changes in relative average wages by education groups, using those with primary school or less education as the base, during the 1978-1996 period. In Figure 2.2, the relative wages of five other education groups are normalized to one in 1978. The difference between the relative wage of an education group in a year and 1 represents the percentage gain or loss in relative wage for the group relative to 1978. Figure 2.2 shows that only those with university degree or above experienced rising wages relative to primary educated workers during 1978-1996, gaining about 9 percent. Other education groups experienced flat or falling wages relative to primary educated workers.

If we only look at the university or above degree workers with 1-10 years of experience, we see a different story. The least experienced university degree recipients lost about 10 percent relative to those with primary or less degree. Among those with only 1-10 years of experience (Figure 2.3), all education groups except junior high school graduates experienced declining relative wages during 1978-1996.

[3] For example, according to Psacharopoulos (1989), the returns to education declined in Greece, Hong Kong, India, Pakistan, Peru, and Venezuela, and rose in Malaysia, South Korea, and Thailand over the 1960s, 1970s, and 1980s.

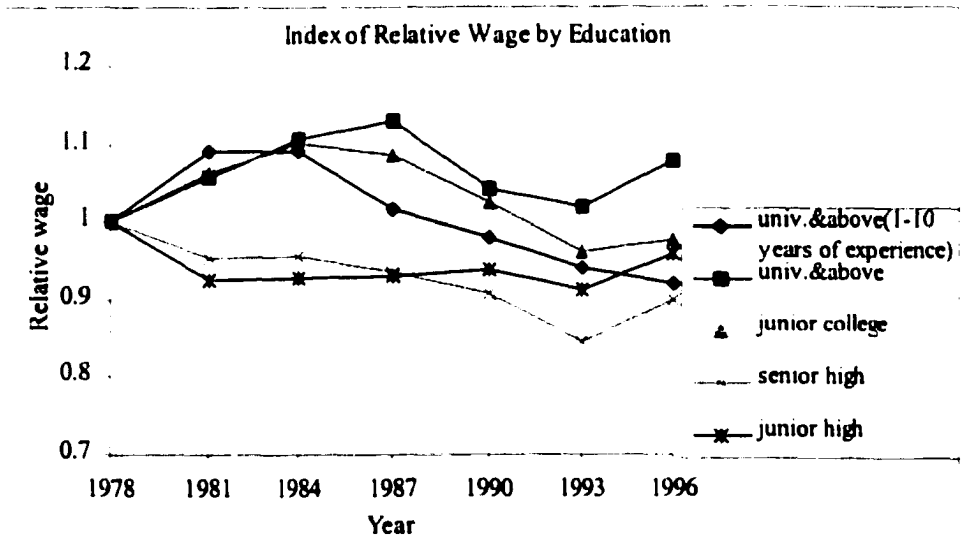

Figure 2.2. Index of Relative Wage by Education

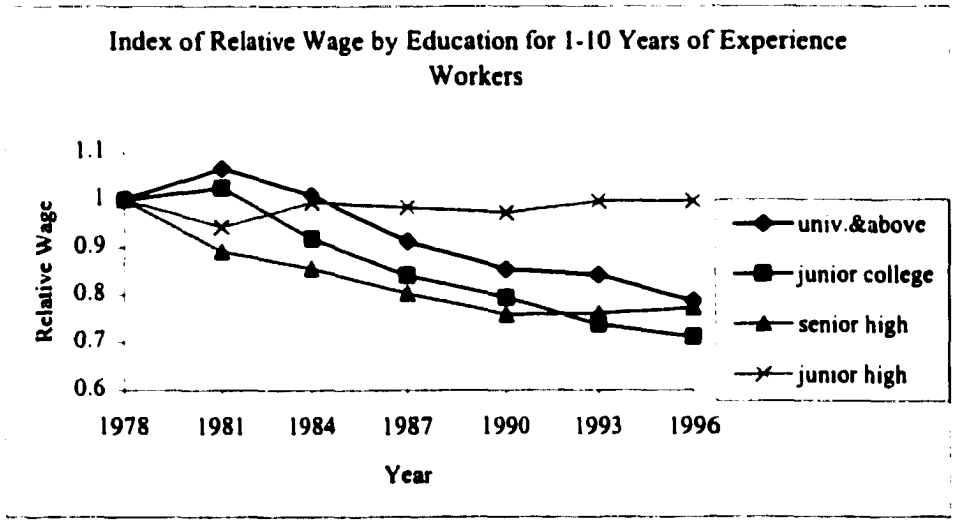

Figure 2.3. Index of Relative Wage by Education for 1-10 Years of Experience Workers

Table 2.9. Log Wage Regressions for Taiwan, 1978-1996 (All Workers)

Variable	1978	1981	1984	1987
JuniorHigh	0.138*	0.114*	0.125*	0.143*
	(10.32)	(8.89)	(10.33)	(12.54)
SeniorHigh	0.352*	0.344*	0.364*	0.360*
	(28.57)	(28.49)	(31.69)	(32.26)
JuniorCollege	0.534*	0.579*	0.603*	0.579*
	(30.81)	(34.78)	(39.65)	(40.28)
Univ.&above	0.669*	0.756*	0.776*	0.779*
	(40.09)	(44.97)	(48.55)	(49.63)
Male	0.418*	0.392*	0.373*	0.348*
	(41.77)	(42.58)	(44.16)	(44.12)
Experience	0.048*	0.050*	0.051*	0.052*
	(33.91)	(37.94)	(41.14)	(45.43)
$Experience^2$	-0.00079*	-0.00081*	-0.00083*	-0.00086*
	(-27.66)	(-30.85)	(-34.26)	(-38.54)
Manufacturing	0.374*	0.432*	0.287*	0.270*
	(24.29)	(30.73)	(18.50)	(17.35)
Electricity	0.568*	0.630*	0.417*	0.448*
	(16.05)	(18.17)	(12.48)	(12.89)
Construction	0.410*	0.472*	0.343*	0.339*
	(21.89)	(27.37)	(19.24)	(19.28)
Commerce	0.500*	0.551*	0.453*	0.388*
	(23.92)	(28.71)	(23.27)	(20.38)
Transportation	0.577*	0.619*	0.462*	0.425*
	(30.00)	(33.08)	(22.95)	(21.15)
F.I.R.E.	0.609*	0.649*	0.540*	0.436*
	(22.00)	(24.67)	(21.60)	(17.42)
SocialService	0.351*	0.417*	0.324*	0.345*
	(20.53)	(25.81)	(18.79)	(20.22)
R^2	0.43	0.45	0.44	0.44
N	11,550	12,905	13,428	13,408

Note: T-Statistics in parentheses.

* Statistically significant at 5 percent level.

Table 2.9 (continued). Log Wage Regressions for Taiwan, 1978-1996 (All Workers)

Variable	1990	1993	1996	78-96[a]	90-96[b]
JuniorHigh	0.148*	0.112*	0.147*	+0.009	-0.001
	(12.30)	(9.13)	(10.33)	(0.63)	(0.07)
SeniorHigh	0.363*	0.283*	0.343*	-0.009	-0.020
	(30.96)	(23.96)	(25.01)	(0.66)	(1.46)
JuniorCollege	0.572*	0.518*	0.558*	+0.024	-0.014
	(39.03)	(36.46)	(34.79)	(1.50)	(0.87)
Univ.&above	0.781*	0.743*	0.799*	+0.130*	+0.018
	(49.99)	(48.96)	(47.67)	(7.76)	(1.07)
Male	0.325*	0.292*	0.260*	-0.158*	-0.065*
	(41.04)	(38.94)	(31.49)	(19.14)	(7.87)
Experience	0.049*	0.046*	0.045*	-0.003*	-0.004*
	(43.28)	(42.44)	(38.43)	(2.56)	(3.42)
Experience^2	-0.00077*	-0.00073*	-0.00068*	+0.00011*	+0.00009*
	(-34.97)	(-33.48)	(-27.45)	(4.44)	(3.63)
Manufacturing	0.312*	0.260*	0.193*	-0.181*	-0.119*
	(17.98)	(13.67)	(7.52)	(7.05)	(4.64)
Electricity	0.558*	0.446*	0.421*	-0.147*	-0.137*
	(16.04)	(11.68)	(9.96)	(3.48)	(3.24)
Construction	0.465*	0.436*	0.290*	-0.120*	-0.175*
	(24.43)	(21.94)	(10.83)	(4.48)	(6.54)
Commerce	0.406*	0.315*	0.256*	-0.244*	-0.150*
	(20.42)	(15.06)	(9.45)	(9.01)	(5.54)
Transportation	0.472*	0.430*	0.360*	-0.217*	-0.112*
	(21.87)	(18.75)	(12.40)	(7.47)	(3.86)
F.I.R.E.	0.496*	0.424*	0.344*	-0.265*	-0.152*
	(21.19)	(18.24)	(11.78)	(9.07)	(5.21)
SocialService	0.383*	0.359*	0.271*	-0.080*	-0.112*
	(20.45)	(18.07)	(10.26)	(3.03)	(4.24)
R^2	0.42	0.40	0.39		
N	13,402	13,835	11,182		

[a] Change in coefficients from 1978-1996 with associated t-statistics testing the null hypothesis that these coefficients are equal in 1978 and 1996.

[b] Change in coefficients from 1990-1996 with associated t-statistics testing the null hypothesis that these coefficients are equal in 1990 and 1996.

Table 2.10. Log Wage Regressions for Taiwan, 1978-1996 (Men)

Variable	1978	1981	1984	1987
JuniorHigh	0.097*	0.069*	0.076*	0.109*
	(6.75)	(4.79)	(5.42)	(8.18)
SeniorHigh	0.310*	0.304*	0.310*	0.312*
	(23.22)	(22.54)	(23.16)	(23.84)
JuniorCollege	0.464*	0.514*	0.535*	0.513*
	(23.91)	(27.16)	(29.94)	(30.57)
Univ.&above	0.644*	0.716*	0.723*	0.735*
	(36.62)	(38.34)	(39.60)	(40.93)
Experience	0.059*	0.067*	0.065*	0.066*
	(35.64)	(41.15)	(40.80)	(44.99)
Experience^2	-0.00100*	-0.00109*	-0.00106*	-0.00109*
	(-29.88)	(-34.80)	(-35.37)	(-39.96)
Manufacturing	0.273*	0.336*	0.264*	0.267*
	(15.04)	(19.74)	(14.24)	(14.90)
Electricity	0.444*	0.501*	0.361*	0.403*
	(11.87)	(13.78)	(10.15)	(11.04)
Construction	0.281*	0.338*	0.273*	0.296*
	(13.75)	(17.61)	(13.59)	(15.30)
Commerce	0.373*	0.433*	0.405*	0.366*
	(15.55)	(19.13)	(17.37)	(16.35)
Transportation	0.436*	0.462*	0.391*	0.384*
	(20.64)	(22.41)	(17.42)	(17.55)
F.I.R.E.	0.500*	0.474*	0.483*	0.382*
	(15.80)	(15.03)	(15.57)	(12.77)
SocialService	0.165*	0.209*	0.222*	0.274*
	(8.22)	(10.82)	(10.83)	(13.79)
R^2	0.3	0.34	0.33	0.36
N	8,507	8,977	9,122	8,852

Note: T-Statistics in the parentheses.

* Statistically significant at 5 percent level.

Table 2.10. (continued) Log Wage Regressions for Taiwan, 1978-1996 (Men)

Variable	1990	1993	1996	78-96[a]	90-96[b]
JuniorHigh	0.110*	0.076*	0.124*	+0.027	+0.014
	(7.77)	(5.05)	(6.94)	(1.51)	(0.78)
SeniorHigh	0.299*	0.216*	0.279*	-0.031	-0.020
	(21.13)	(14.75)	(15.84)	(1.76)	(1.14)
JuniorCollege	0.475*	0.421*	0.466*	+0.002	-0.009
	(26.91)	(24.04)	(22.75)	(0.10)	(0.45)
Univ.&above	0.698*	0.666*	0.717*	+0.073*	+0.019
	(37.79)	(36.22)	(33.86)	(3.45)	(0.90)
Experience	0.060*	0.056*	0.054*	-0.005*	-0.006*
	(40.28)	(39.26)	(33.64)	(3.11)	(3.75)
Experience^2	-0.00096*	-0.00090*	-0.00084*	+0.00016*	+0.00012*
	(-34.42)	(-32.66)	(-25.98)	(4.95)	(3.71)
Manufacturing	0.302*	0.269*	0.193*	-0.080*	-0.109*
	(14.89)	(11.97)	(6.32)	(2.62)	(3.57)
Electricity	0.502*	0.418*	0.394*	-0.050	-0.108*
	(13.32)	(10.23)	(8.46)	(1.07)	(2.32)
Construction	0.397*	0.393*	0.245*	-0.036	-0.152*
	(18.55)	(17.16)	(7.89)	(1.16)	(4.90)
Commerce	0.371*	0.293*	0.233*	-0.140*	-0.138*
	(15.58)	(11.61)	(7.09)	(4.26)	(4.20)
Transportation	0.412*	0.372*	0.320*	-0.116*	-0.092*
	(17.10)	(14.17)	(9.56)	(3.47)	(2.75)
F.I.R.E.	0.429*	0.378*	0.257*	-0.243*	-0.172*
	(14.84)	(13.04)	(7.12)	(6.73)	(4.78)
SocialService	0.306*	0.288*	0.206*	+0.041	-0.100*
	(13.75)	(12.13)	(6.48)	(1.29)	(3.12)
R^2	0.42	0.40	0.39		
N	8,564	8,605	6,636		

[a] Change in coefficients from 1978-1996 with associated t-statistics testing the null hypothesis that these coefficients are equal in 1978 and 1996.

[b] Change in coefficients from 1990-1996 with associated t-statistics testing the null hypothesis that these coefficients are equal in 1990 and 1996.

Table 2.11. Log Wage Regressions for Taiwan, 1978-1996 (Women)

Variable	1978	1981	1984	1987
JuniorHigh	0.264*	0.226*	0.237*	0.205*
	(8.81)	(9.30)	(10.59)	(9.84)
SeniorHigh	0.456*	0.418*	0.458*	0.434*
	(16.25)	(17.60)	(21.55)	(21.08)
JuniorCollege	0.712*	0.740*	0.754*	0.712*
	(19.93)	(23.76)	(27.42)	(26.87)
Univ.&above	0.846*	0.911*	0.939*	0.885*
	(20.25)	(27.22)	(30.21)	(29.14)
Experience	0.044*	0.039*	0.042*	0.038*
	(15.50)	(17.19)	(20.19)	(19.52)
$Experience^2$	-0.00078*	-0.00066*	-0.00067*	-0.00057*
	(-12.28)	(-13.26)	(-15.40)	(-13.60)
Manufacturing	0.502*	0.563*	0.384*	0.377*
	(18.33)	(24.64)	(14.25)	(12.65)
Electricity	0.738*	0.945*	0.611*	0.719*
	(8.06)	(9.76)	(6.11)	(7.04)
Construction	0.465*	0.619*	0.444*	0.429*
	(8.87)	(15.32)	(10.76)	(10.43)
Commerce	0.665*	0.688*	0.550*	0.495*
	(16.71)	(21.00)	(16.51)	(14.13)
Transportation	0.776*	0.879*	0.638*	0.543*
	(15.78)	(19.44)	(13.37)	(10.89)
F.I.R.E.	0.708*	0.866*	0.632*	0.602*
	(13.43)	(19.97)	(15.55)	(13.59)
SocialService	0.598*	0.695*	0.495*	0.520*
	(18.69)	(25.53)	(16.46)	(16.11)
R^2	0.41	0.47	0.40	0.37
N	3,043	3,928	4,306	4,556

Note: T-Statistics in the parentheses.

* Statistically significant at 5 percent level.

Table 2.11. (continued) Log Wage Regressions for Taiwan, 1978-1996 (Women)

Variable	1990	1993	1996	78-96[a]	90-96[b]
JuniorHigh	0.184*	0.134*	0.144*	-0.120*	-0.040
	(8.47)	(6.53)	(6.30)	(5.25)	(1.75)
SeniorHigh	0.441*	0.351*	0.410*	-0.046*	-0.031
	(21.56)	(17.94)	(18.80)	(2.11)	(1.41)
JuniorCollege	0.733*	0.634*	0.662*	-0.050	-0.071*
	(28.90)	(26.59)	(25.87)	(1.94)	(2.77)
Univ.&above	0.931*	0.845*	0.909*	+0.063*	-0.022
	(33.16)	(32.20)	(33.42)	(2.32)	(0.81)
Experience	0.042*	0.040*	0.040*	-0.004*	-0.002
	(23.46)	(23.15)	(22.95)	(2.30)	(1.15)
Experience^2	-0.00065*	-0.00062*	-0.00058*	+0.00020*	+0.00007
	(-16.79)	(-16.76)	(-14.60)	(5.03)	(1.76)
Manufacturing	0.411*	0.306*	0.267*	-0.235*	-0.144*
	(12.94)	(9.00)	(5.80)	(5.10)	(3.13)
Electricity	0.812*	0.573*	0.512*	-0.226*	-0.300*
	(9.58)	(5.27)	(4.97)	(2.19)	(2.91)
Construction	0.604*	0.511*	0.356*	-0.109*	-0.248*
	(14.70)	(13.16)	(6.86)	(2.10)	(4.78)
Commerce	0.533*	0.390*	0.353*	-0.312*	-0.180*
	(15.11)	(10.65)	(7.44)	(6.58)	(3.79)
Transportation	0.623*	0.567*	0.443*	-0.333*	-0.180*
	(13.28)	(12.60)	(7.81)	(5.87)	(3.17)
F.I.R.E.	0.643*	0.512*	0.490*	-0.218*	-0.153*
	(16.21)	(13.05)	(9.79)	(4.36)	(3.06)
SocialService	0.534*	0.476*	0.394*	-0.204*	-0.140*
	(15.85)	(13.52)	(8.44)	(4.37)	(3.00)
R^2	0.39	0.37	0.36		
N	4,838	5,230	4,546		

[a] Change in coefficients from 1978-1996 with associated t-statistics testing the null hypothesis that these coefficients are equal in 1978 and 1996.

[b] Change in coefficients from 1990-1996 with associated t-statistics testing the null hypothesis that these coefficients are equal in 1990 and 1996.

Next, we look at the estimated *ceteris paribus* logarithmic wage equation in Table 2.9. The coefficients on the education level dummy variables remained virtually unchanged during 1978-1996. In the last two columns of Table 2.9, we can see only the returns to education for those with at least 4-year college degree had significant change for the entire 1978-1996 period. During 1990-1996, when the educational reform and importation of foreign unskilled labor took place, none of the coefficients on education dummy variables changed statistically significantly. That means if we control for other variables, relative wages for education groups were stable during 1990-1996.

The returns to education were different for men and women (Table 2.10 and 2.11). The returns to education relative to primary education were higher for women than for men at all education levels during 1978-1996. Deolalikar (1993) argued that a selection problem in the sample data might be the possible reason. Only those women who are more intelligent or productive are in the labor market. Therefore, the women in the job market might be more productive than are men with the same education level.

Figure 2.4 shows the time path of the college premium, defined as the difference in coefficients between university or above and senior high school dummy variables, for all workers and for workers with less than 10 or more than 10 years of experience. The college premium for all workers grew slowly, but returns for experience groups had different paths. The college premium was higher for the least experienced before 1990, but returns for the more experienced workers overtook those for the young after 1990. It appears that the education policy which increased the number of 4-year colleges, which in turn increased the number of college graduates every year, has lowered the return to college education for the young. However, this policy did not affect the more experienced college graduate workers.

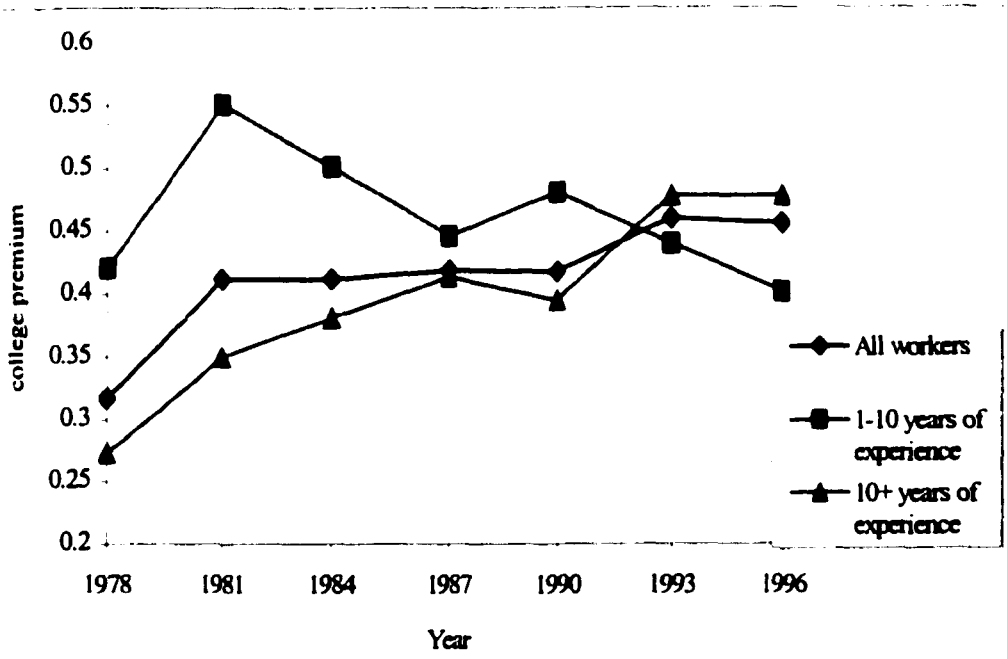

Figure 2.4. College Premium for All Workers and for Workers with 1-10 Years and Workers with More Than 10 Years of Experience

Instead of falling, the return to college education rose for the more experienced cohort throughout the 1978-1996 period. The result in Figure 2.4 when holding other factors constant is consistent with the pattern of average returns in Figures 2.2 and 2.3. The estimations of log wage equations for these two experience groups are shown in Appendix D.

The declining relative return to education for the least experienced after 1990 may be due to declining average quality of college graduates. The pass rate on the university entrance examination increased from 37.3 percent in 1990 to 49.2 percent in 1996 due to many newly established 4-year colleges. Most of the new 4-year colleges were actually 2-year junior colleges before 1990. But the quality of instructors and research environment did not improve too much after they upgraded to 4-year colleges, although they still had to satisfy certain standards set by the government.

Returns to education differ across industries. Relative demand for workers with the same education level, gender and experience are different in different industries. For example, in Figure 2.5, relative wage for workers with university degrees rose over time in electricity, commerce, and social/personal services industries, which are relatively skilled-labor intensive. Relative returns to university education fell in agriculture, mining and quarrying which is relatively unskilled-labor intensive.

Returns to experience

From the coefficients in log-wage regression results, we can see that returns to experience have fallen over time and the changes were statistically significant over the periods of 1990-1996 and 1978-1996. However, the magnitude of decline was quite small. The decrease of returns to experience was larger for men than women. The change for women in the period of 1990-1996 was considered statistically insignificant. Also the returns to experience were higher for men than for women in the entire 1978-1996 period. Gannicott (1986) pointed out that female-male earnings gap also took place through experience in Taiwan. With the same experience, other things held constant, women receive lower earnings than men. One thing needs to be mentioned here is that the experience we calculate is potential work experience (age – years of schooling – 6), not actual work experience. Women's actual work experience is normally shorter than their potential work experience due to work interruptions attributable to marriage, and having and raising children.

The linear term (EXP) in pooled log-wage regression was significantly reduced between 1978 and 1996, and the quadratic term (EXP^2) was significantly increased between

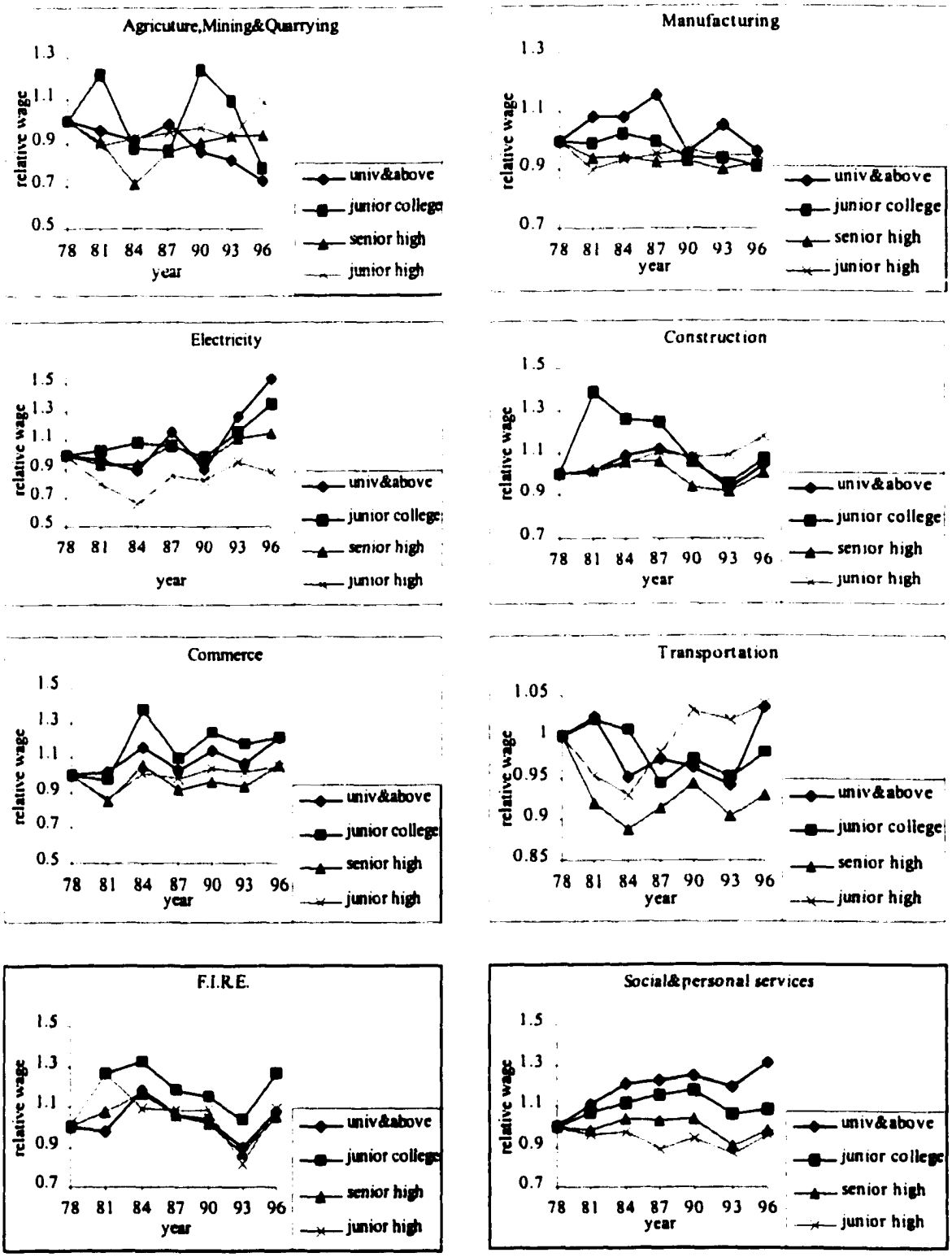

Figure 2.5. Relative wages by Education in Industry

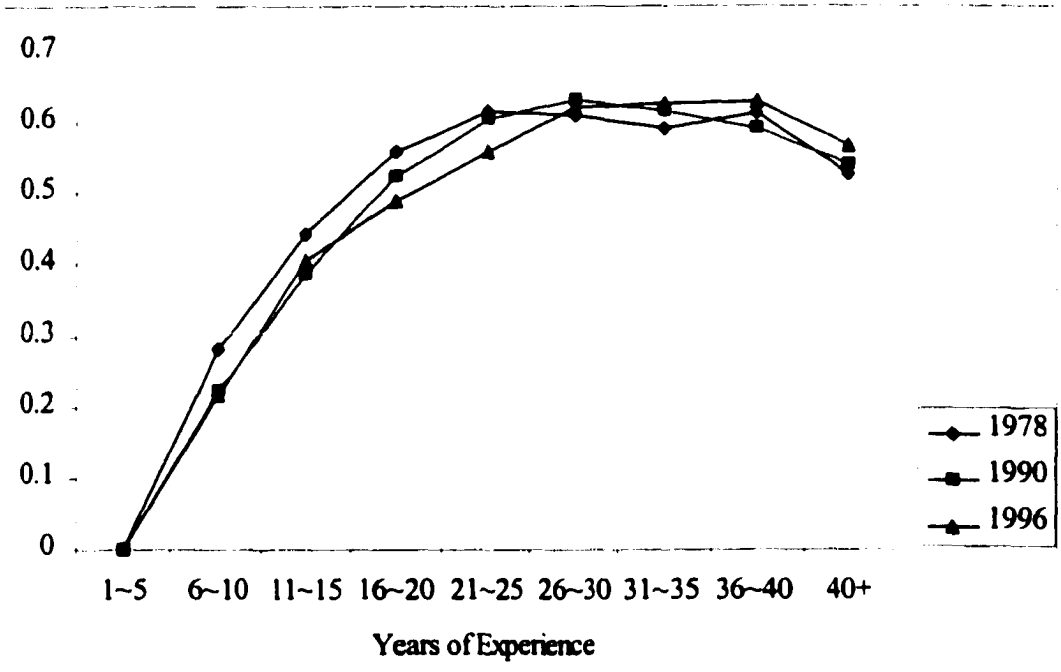

Figure 2.6. Returns to Years of Experience Relative to 1-5 Years of Experience

1978 and 1996. This is consistent with Figure 2.6, which shows that the marginal returns to a year of experience fell for the young workers and rose for the old workers. We can see that the wage-experience profile in 1996 is flatter than in 1978 for the young workers. The estimated coefficients of EXP and EXP^2 imply that the peak of life-cycle earnings has been moved from 30.4 years of experience in 1978, 31.8 years of experience in 1990 to 33.1 years of experience in 1996.

Figure 2.7 shows that the wage-experience profiles relative to economy average by education in 1978, 1990, and 1996. We can see the workers with primary or less degree earned even more than those with junior high degree in the 1-5 years of experience category in 1990 but returned to normal in 1996. For university or above degree workers in 1-5 years of experience category, the average wage was about 47 percent higher than the economy

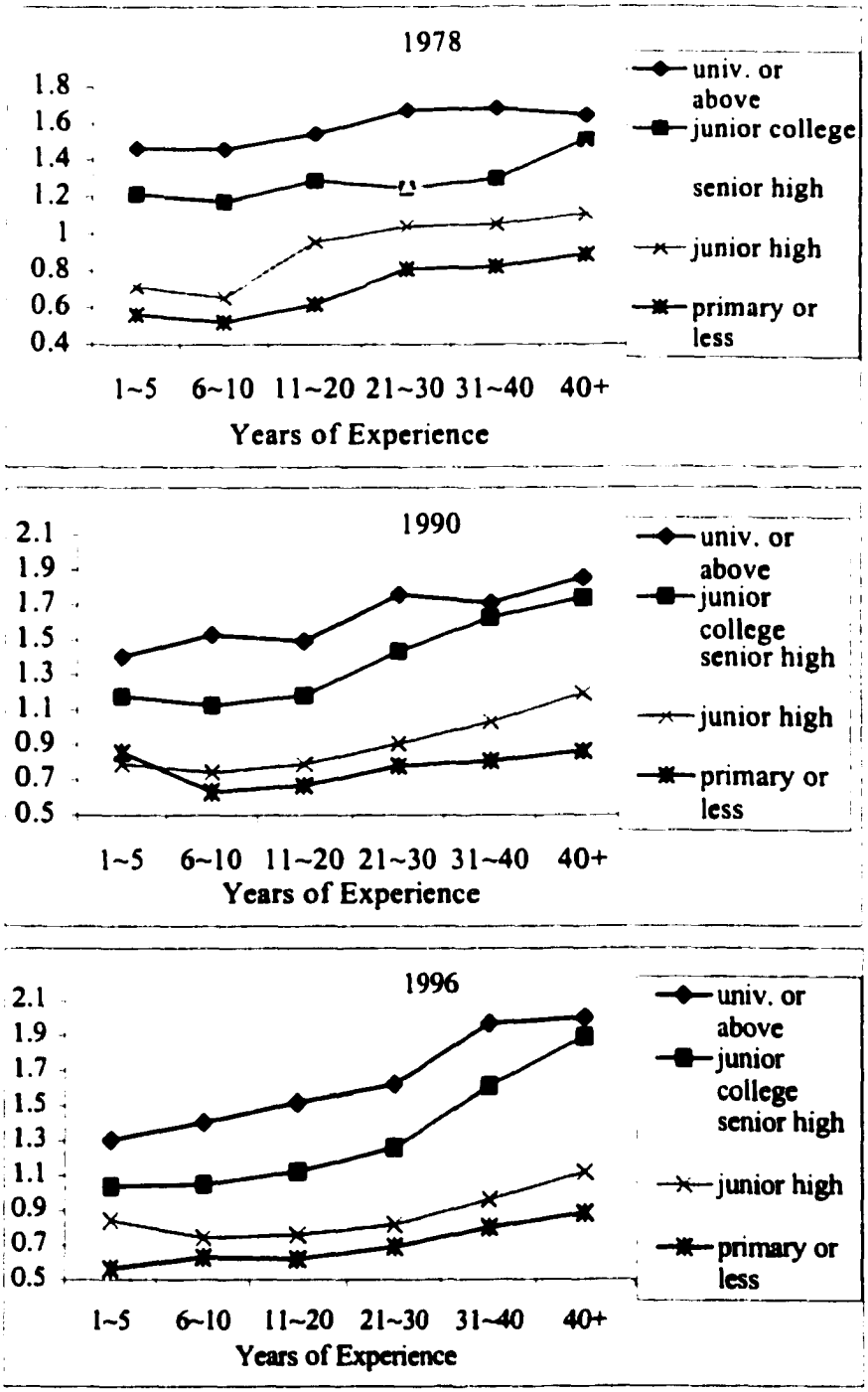

Figure 2.7. Wage-Experience Profiles Relative to Economy Average by Education Level, 1978, 1990, 1996

average in 1978, but only about 40 and 30 percent higher than the economy averages in 1990 and 1996, respectively. For primary or less degree workers in 1-5 years of experience category, the average wages were about 40 percent lower than the economy averages in 1978 and 1996, but was about only 14 percent lower than the economy average in 1990.

Female-male earnings gap

The evidence presented in the earlier section shows that women's share in each sector increased dramatically during the 1978-1996 period. The labor force participation rate for women increased from 39.1 percent in 1978 to 45.8 percent in 1996, but it was still well below that in most developed countries, which have at least 50 percent in the 1990's. To see how well women did in the labor market during this period, we will look at this issue from several perspectives.

First, the female-male wage ratio in Table 2.12 shows that women earned only 60 percent of men's average wage in 1978. The ratio continuously increased to 74 percent by 1996. That implies the log wage gap, defined as the natural log of average wages for women minus the natural log of average wages for men, decreased from 0.56 in 1978 to 0.32 in 1996. The median women's wage in 1978 was only at the 18^{th} percentile of the men's wage distribution, while it increased to 23^{rd} in 1984, 26^{th} in 1990, and 32^{nd} in 1996.

The economic progress for Taiwanese women relative to men is similar to that of the United States. The female-male earnings ratio rose from 60 percent in 1980 to 76 percent in 1998 for the U.S. (Kaufman and Hotchkiss (1999)), but the median women's wage in the U.S. was at the 31^{st} percentile of the men's wage distribution in 1991 (Blau and Kahn (1994)), compared to 26^{th} percentile for Taiwanese women in 1990.

Table 2.12 Changes in Women's Wage Relative to Men's Wage, Taiwan, 1978-1996

	Observed Wage			Standardized Residual after controlling for human capital and Working sectors	
Year	Female-male earnings ratio	Log-wage gap[a]	Position[b]	Difference[c]	Position[b]
1978	0.60	-0.56	0.18	-0.9563	0.17
1984	0.63	-0.48	0.23	-0.8652	0.19
1990	0.68	-0.41	0.26	-0.7973	0.21
1996	0.74	-0.32	0.32	-0.6375	0.26

a. The difference between natural log of women's average wage and natural log of men's average wage.
b. Percentile position of women's average wage in the men's wage distribution.
c. The value of θ_F.

After controlling for human capital and working sectors, the standardized residual for women, $\theta_F = \frac{(W_{Ft} - X_{Ft}\beta_{Mt})}{\sigma_{Mt}}$, has been decreasing in absolute value since 1978, implying the relative position for women has been increasing from the 17th percentile to 26th percentile of men's residual earnings distribution. The economic interpretation of $(W_{Ft} - X_{Ft}\beta_{Mt})$ can be referred to as unexplained wage differentials between women and men. If this value is negative, that means women are earning less than men with the same characteristics in human capital and working sectors. Women's relative position in the residual distribution lags behind their relative position in observed wages, suggesting that women have been gaining in part by acquiring human capital relative to men. However, their position in the residual distribution has also improved during 1978-1996 period.

Table 2.13 shows the differences between women and men in the log wage equation coefficients from 1978 to 1996. Positive values imply that the coefficient in the women's log wage equation is larger than the coefficient in the men's log wage equation. We can see that the returns to education are much higher for women than men. However, the magnitude of these differences is decreasing over time. The values of t-statistics on the hypothesis that each pair of coefficients for men and women is equal are also decreasing over time for most independent variables. The differences between men and women in return to education in junior high school and return in industries manufacturing and electricity are statistically insignificant in 1996. The rapid economic growth in Taiwan during this period improved not only all workers' wages, but also narrows the pricing gap between men and women in characteristics.

Table 2.13 Difference in Returns to Characteristics Between Men and Women, Taiwan, 1978-1996

Variable	1978	1984	1990	1996
Constant	-0.583*	-0.386*	-0.399*	-0.353*
	(14.80)	(10.70)	(10.24)	(6.83)
JuniorHigh	0.167*	0.161*	0.074*	0.020
	(5.57)	(7.19)	(3.41)	(0.88)
SeniorHigh	0.146*	0.148*	0.142*	0.131*
	(5.20)	(6.96)	(6.94)	(6.00)
JuniorCollege	0.248*	0.219*	0.258*	0.196*
	(6.94)	(7.96)	(10.17)	(7.66)
Univ.&above	0.202*	0.216*	0.233*	0.192*
	(4.84)	(6.95)	(8.30)	(7.06)
Experience	-0.015*	-0.0238*	-0.018*	-0.014*
	(-5.28)	(-11.06)	(-10.05)	(-8.03)
Experience^2	0.00022*	0.00039*	0.00031*	0.00026*
	(3.46)	(8.96)	(8.01)	(6.54)
Manufacturing	0.229*	0.120*	0.109*	0.074
	(8.36)	(4.45)	(3.43)	(1.61)
Electricity	0.294*	0.250*	0.310*	0.118
	(3.21)	(2.50)	(3.66)	(1.15)
Construction	0.184*	0.171*	0.207*	0.111*
	(3.51)	(4.14)	(5.04)	(2.14)
Commerce	0.292*	0.145*	0.162*	0.120*
	(7.34)	(4.35)	(4.59)	(2.53)

Note: The differences represent the coefficients in the women's log wage equation minus the coefficients in the men's log wage equation.

T-statistics are in parentheses.

* Statistically significant at 5 percent level.

Table 2.13(continued)

Transportation	0.340*	0.247*	0.211*	0.123*
	(6.91)	(5.18)	(4.50)	(2.17)
F.I.R.E.	0.208*	0.149*	0.214*	0.233*
	(3.95)	(3.67)	(5.39)	(4.66)
SocialService	0.433*	0.273*	0.228*	0.188*
	(13.53)	(9.08)	(6.77)	(4.03)

Using the methodology from Juhn, Murphy, and Pierce (1993) and the demonstration in Orazem and Vodopivec (1995), we can decompose the change in the male-female wage gap between year t and t' as

$$[(X_{Mt'} - X_{Mt}) - (X_{Ft'} - X_{Ft})]\beta_{Mt'} + (X_{Mt} - X_{Ft})(\beta_{Mt'} - \beta_{Mt})$$

$$+ [(\theta_{Mt'} - \theta_{Ft'}) - (\theta_{Mt} - \theta_{Ft})]\sigma_{Mt'} + (\theta_{Mt} - \theta_{Ft})(\sigma_{Mt'} - \sigma_{Mt})$$

where X_M and X_F are the vectors of independent variables for male and female workers, β_M and β_F are the corresponding estimates in log-wage equation regression. σ_{Mt} is the standard deviation of the residual of the male wage equation in year t, $\theta_{Mt} = \frac{e_{Mt}}{\sigma_{Mt}}$ is the standardized residual of the regression, and $\theta_{Ft} = \frac{(W_{Ft} - X_{Ft}\beta_{Mt})}{\sigma_{Mt}}$. The first term in the above expression captures how the wage gap changes in response to changes in characteristics between men and women. The second term measures how changes in the returns to these characteristics affect the wage gap. The third term represents how the change in women's relative position in the male residual earnings distribution affects the wage gap. The fourth term shows increases in the standard deviation of the residual earnings distribution affect the wage gap. The sum of the first two terms can represent the explained differences between men and women, and the sum of the last two terms can represent the unexplained differences. This is the basic idea of Blau and Kahn (1994) decomposition. These four terms are labeled as "Observed X's", "Observed Prices", "Gap", and "Unobserved Prices" respectively. By

Table 2.14 Standard Deviations of Residuals and Standardized Residuals

	1978	1984	1990	1996
σ_M	0.4235	0.4192	0.4010	0.3937
σ_F	0.4516	0.4076	0.4068	0.4015
θ_M	0	0	0	0
θ_F	-0.9563	-0.8652	-0.7973	-0.6375

looking at these components over time, we can trace out the wage discrimination against women over this period.

Table 2.14 reports the standard deviations of the residuals from men's and women's log wage equations, σ_M and σ_F, which can be interpreted as a measure of the variation in wages that is uncorrelated with workers' observed human capital and working sectors, over the 1978-1996 period. The standardized residuals, θ_M and θ_F are also shown in the Table. The magnitude of both measures decreases for men and women over this period, implying the wage inequality declines among men and among women.

The four components of decomposition of change in male-female wage gap are shown in Table 2.15. Negative numbers indicate factors that increase women's wages in comparison with men's wages. All components have negative values for the entire 1978-1996 period, and all are negative in all subperiods with the exception of the component "Observed Prices" in 1978-1984, 1984-1990 and the entire 1978-1996 periods, however their values are quite small. The male-female wage gap is reduced through three of these four components, but most significantly through the "Gap" component. That implies that women

Table 2.15 Decomposition of Change in Women's Relative Log Wage, Taiwan, 1978-1996

	1978-1984	1984-1990	1990-1996	1978-1996
1. Observed X's[a]	-0.0428	-0.0371	-0.0184	-0.0983
2. Observed prices[b]	0.0027	0.0103	-0.0013	0.0117
3. Gap[c]	-0.0383	-0.0273	-0.0635	-0.1291
4. Unobserved prices[d]	-0.0040	-0.0157	-0.0058	-0.0255
Total (1+2+3+4)	-0.0824	-0.0698	-0.0890	-0.2412
Explained changes (1+2)	-0.0401	-0.0268	-0.0197	-0.0866
Unexplained changes (3+4)	-0.0423	-0.0430	-0.0693	-0.1546

Note: Negative numbers indicate factors that increase women's wage in comparison with men's wage.

[a] How the wage gap changed in response to changes in characteristics between men and women.

[b] How changes in the returns to characteristics affected the wage gap.

[c] How the change in women's relative position in the men's residual wage distribution affected the wage gap.

[d] How increases in the standard deviation of the residual wage distribution affected the wage gap.

have been gaining their relative position in men's residual earnings distribution, particularly in the 1990-1996 period. The second important factor in the decomposition is the "Observed X's" component, implying women are gaining more education and experience relative to men, especially in the first two subperiods.

The sum of the first two components comprises the "explained" change in the wage gap, which contributes only 36 percent of the total change. The majority of change in the female-male wage gap occurs through the "unexplained" part, the sum of last two components. The magnitude of this part has been increasing since 1978-1984 period. This might be due to better civil rights for Taiwanese women and affirmative action legislation in recent years.

The increase in relative supply of female workers did not widen the gender wage gap over the 1978-1996 period. If the industries that hire relatively large numbers of women start to expand, the wage gap should be able to be reduced. This is exactly what happen and what we found after 1978. Finance, Insurance, and Real Estate, Commerce, and Social Services have the largest employment growth (more than 100 percent) over 1978-1996, while their women shares in the total industry employment increased to more than 50 percent in 1996 (see Table 2.16).

Although gender wage gap in Taiwan has been significantly reduced, wage differentials continue to persist. The average women's wage is only at the 26^{th} percentile of the men's wage distribution after controlling for human capital and working sectors in 1996. By looking at the gender wage differentials by industry in Table 2.16, we see that Agriculture, Mining and Quarrying, and Manufacturing have the lowest earnings ratios, while Transportation, F.I.R.E. and Services have the highest earnings ratios. As we

Table 2.16 Total Employment, Women Share and Wage Differentials by Industry, Taiwan, 1978-1996

	1978			1984			1990			1996		
Sector	Total Employment	Women Share	Wage Differentials	Total Employment	Women Share	Wage Differentials	Total Employment	Women Share	Wage Differentials	Total Employment	Women Share	Wage Differentials
Agriculture, Mining&Quarrying	1.6 M*	37.1%	0.42	1.3 M	29.6%	0.50	1.1 M	28.8%	0.51	0.9 M	30.4%	0.66
Manufacturing	1.9 M	29.4%	0.53	2.5 M	39.0%	0.55	2.7 M	40.8%	0.59	2.4 M	41.2%	0.65
Electricity, Gas&Water	0.03 M	14.2%	0.66	0.03 M	8.9%	0.72	0.04 M	14.8%	0.84	0.04 M	13.5%	0.73
Construction	0.5 M	7.9%	0.56	0.5 M	10.0%	0.62	0.7 M	12.9%	0.70	0.9 M	15.7%	0.75
Commerce	0.9 M	28.0%	0.65	1.3 M	36.2%	0.61	1.6 M	42.1%	0.69	2.0 M	51.3%	0.69
Transportation, Storage&Communication	0.3 M	11.2%	0.70	0.4 M	11.7%	0.75	0.4 M	16.0%	0.78	0.5 M	19.8%	0.82
Finance, Insurance &Real Estate (F.I.R.E.)	0.07 M	28.9%	0.53	0.1 M	40.6%	0.61	0.2 M	45.3%	0.69	0.3 M	50.5%	0.78
Social, Personal Services &Public Administration	0.9 M	31.6%	0.75	1.2 M	36.9%	0.73	1.6 M	45.1%	0.76	2.0 M	53.1%	0.77
Total	6.2 M	26.4%	0.60	7.3 M	32.1%	0.63	8.3 M	36.1%	0.68	9.1 M	40.7%	0.74

*: Million

discussed earlier, in recent years employment has shifted from Agriculture, Mining and Quarrying, and Manufacturing to F.I.R.E., Commerce, and Services sectors, where women do not face a physical disadvantage. Continuation of these shifts suggests that Taiwanese women will continue to gain in relative wages in the future.

Changes in wage inequality

Per capita GDP in Taiwan grew significantly during the past three decades, which is expected to reduce poverty and increase living standard. Taiwan also had an extraordinarily equal distribution of earnings during the 1960s, 1970s and 1980s (Fei, Ranis and Kuo (1978), Galenson (1979) and Fields (1984)). By Fields's calculation, Taiwan's Gini coefficient for households was 0.30 in 1987, which was the lowest among non-socialist, developed or developing, countries. This is just the opposite case for the United States and other developed countries during 1970s, 1980s and 1990s, which have been experiencing slow wage growth and rapid increase in earnings inequality.

The average real wage increased 131 percent overall during 1978-1996, while it increased 128 percent for men and 183 percent for women. Figure 2.8 shows that the ratio of the worker's wage at the 90^{th} percentile to the wage at the 10^{th} percentile during 1978-1996. The good thing for using this ratio is that we can avoid the problem of " top-coding". The ratio declined from 1978 to 1996 for all workers. The most striking point here is the ratio for women has been significantly decreasing since 1978, while the ratio for men remains very constant during this period. This suggests that the gap between the rich and the poor for women has been significantly reduced from 1978 to 1996.

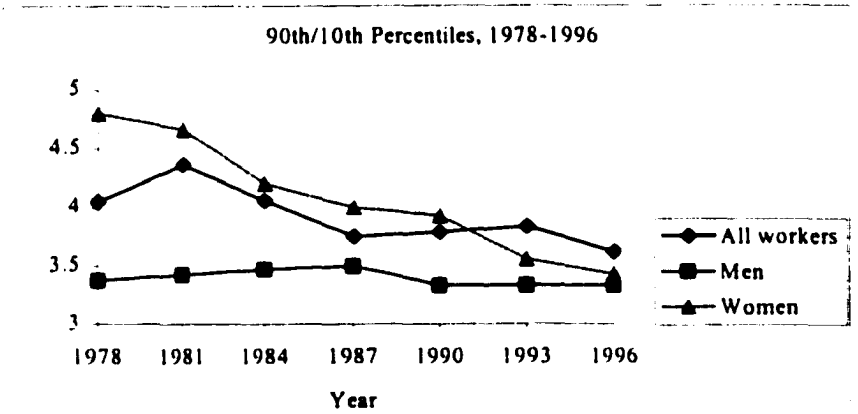

Figure 2.8 $90^{th}/10^{th}$ Percentiles in Wages, 1978-1996

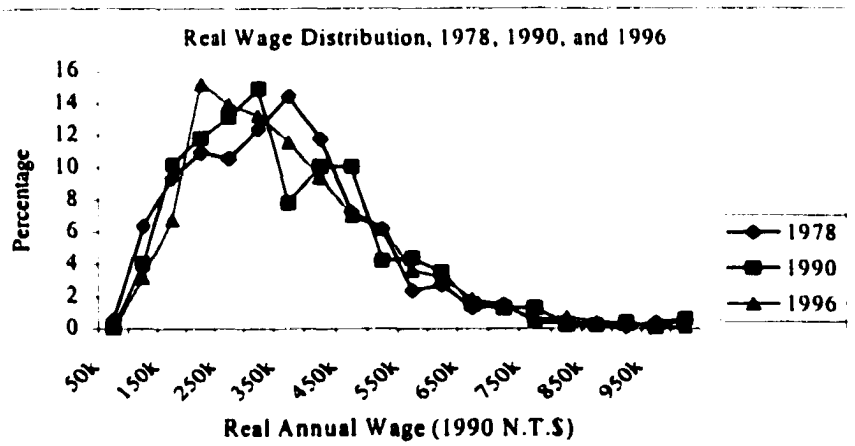

Figure 2.9 Real Wage Distribution, 1978, 1990, and 1996

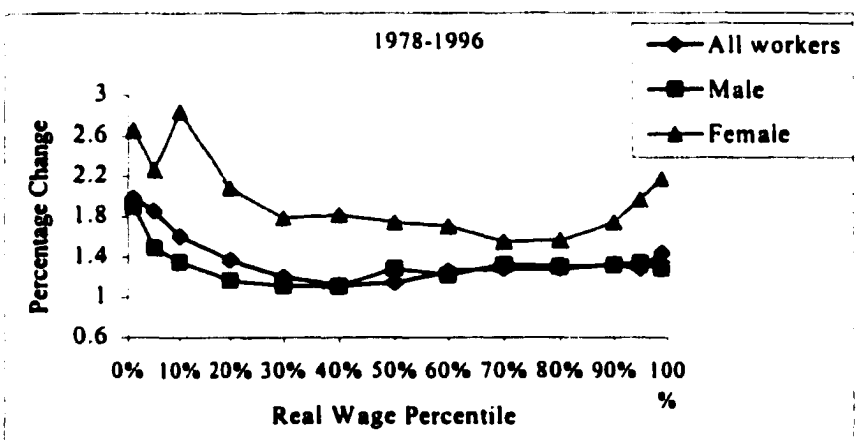

Figure 2.10 Changes in Real Wages by Percentile, 1978-1996

In Figure 2.9, the real wage distribution for all workers are presented for 1978, 1990 and 1996. To make it easier to compare the changes in the wage distribution, the real wages in 1978 and 1996 are deflated by the ratios of median wages of 1978 and 1996 to median wage in 1990 so that the median wages in 1978, 1990 and 1996 are equal. We can see that there has been a decreasing number of workers at the lower tail and larger number of workers at the middle of the distribution since 1978. The percentage of workers in the upper tail virtually remained constant during the 1978-1996 period. From this figure it is not clear that the earnings inequality was reduced during 1978-1996, but the distribution has become more skewed to the right, which implies that the poverty rate has declined during this period.

The changes in the mean of the real wage distribution tell the same story as above. Figure 2.10 illustrates the percentage change in real wage by percentile during 1978-1996. We can see larger growth occurs at the lower end, i.e., lower rank workers gained more than the other workers. The patterns were quite similar for men and women except that the higher rank women were still gaining more than the middle class women while the gains for the middle and higher rank men were about the same. However, the growth in wages for women was always higher than it for men in every decile. As mentioned earlier, the growth in real wage during this period was 131 percent overall. That is the workers which were below the 20^{th} percentile and above 85^{th} percentile gained relative to other workers. Again, from this analysis, we can't clearly tell the trend of earnings inequality, but at least we know the inequality couldn't increase significantly if it really increased during this period.

The changes in the mean differences between education groups can also be captured by the changes in the coefficients on the education dummy variables in regression. The changes for the coefficients of four education dummy variables between 1978 and 1996 were

Table 2.17. Coefficients of Variation of Real Wage Within Groups, 1978-1996

Group	1978	1981	1984	1987	1990	1993	1996
All workers	0.62	0.58	0.59	0.58	0.56	0.53	0.56
Education							
Univeristy and above	0.65	0.55	0.47	0.56	0.45	0.44	0.50
Junior college	0.65	0.41	0.50	0.45	0.53	0.44	0.48
Senior high	0.53	0.52	0.56	0.51	0.51	0.49	0.51
Junior high	0.51	0.54	0.53	0.49	0.49	0.47	0.47
Primary and below	0.54	0.54	0.51	0.47	0.50	0.51	0.44
Experience							
1-5 years	0.55	0.53	0.51	0.43	0.44	0.42	0.40
6-10 years	0.54	0.59	0.64	0.52	0.46	0.44	0.46
11-20 years	0.63	0.52	0.56	0.57	0.50	0.50	0.51
21-30 years	0.68	0.55	0.59	0.56	0.56	0.54	0.56
31-40 years	0.54	0.62	0.55	0.54	0.65	0.52	0.59
40+ years	0.54	0.61	0.55	0.56	0.53	0.55	0.54
Gender							
Male	0.57	0.52	0.54	0.53	0.50	0.48	0.51
Female	0.63	0.60	0.59	0.58	0.59	0.56	0.59
Residual standard deviation							
Male	0.42	0.43	0.42	0.39	0.40	0.40	0.39
Female	0.45	0.43	0.41	0.40	0.41	0.40	0.40

Source: Author's calculation.

statistically insignificant except for the highest-educated group, implying little change in education premium during 1978-1996, holding other factors, such as experience, gender and working industry, constant.

Experience premium, measured by the coefficient of EXP variable in log-wage regression equation, decreased during 1978-1996 for both men and women. The measured decrease in experience premium suggests that wage inequality between experience groups has been reduced.

Changes in wage inequality not only occur among those groups with different characteristics we discussed above, but also happen within groups. In Table 2.17, coefficients of variation for different characteristic groups are calculated. The coefficient of variation for a group is defined as the standard deviation divided by the mean of the group. The results show a very consistent story as we discussed earlier. The overall inequality was gradually reduced during 1978-1996. However, the variance for the most-educated group increased between 1990 and 1996 while other education groups either decreased or remained unchanged. The decrease in relative wage of the young 4-year college graduate workers might have caused larger inequality within the group.

The inequality within experience groups and gender groups also decreased over time between 1978 and 1996.

The residual standard deviations provided on the bottom of Table 2.17, controlling the observed variables in log-wage regression equation for men and women, tell the similar story as above.

Summary

The results found in this chapter indicate several structural changes in the Taiwan labor market between 1978 and 1996. We summarize these changes as follows.

1. The relative employment in Commerce, F.I.R.E., and Construction increased dramatically in this period, while the relative employment of Agriculture, Forestry, Fishery, Mining and Quarrying continued to decline. Manufacturing industry, which imported most of the foreign low-skilled workers starting from 1990, suffered employment loss between 1990 and 1996. On the other hand, Construction and Services industries, which also imported a portion of the foreign low-skilled workers, gained modestly relative to the labor market as a whole in the same period.
2. The relative employment decreased for the lower-educated workers, while it increased substantially for the higher-educated workers during 1978-1996.
3. The relative employment fell for the old workers and rose for the young workers during 1978-1996. The relative employment for young educated workers increased sharply in this period.
4. Women's relative employment increased in this period, especially for the higher-educated women.
5. The college wage premium for all workers remained unchanged during the 1978-1996 period, but it declined over time for the young (1-10 years of experience) workers since 1990.
6. Female-male wage gap narrowed from 1978 to 1996, particularly in the 1990-1996 period. Most of this change came from the "unexplained" part.

7. Overall wage inequality decreased over time since 1978. Wage inequality between and within various demographic groups either declined or remained unchanged during the 1978-1996 period.

CHAPTER 3

THE HYPOTHESES AND THEORETICAL FRAMEWORK

The Hypotheses

The two labor supply shocks, foreign low-skilled workers and domestic high-skilled workers, would be expected to cause structural changes to relative employment and wages in the Taiwan labor market. The effects of foreign low-skilled workers on the employment and wages of domestic workers will be discussed later in Chapter 4.

The increase of supply in domestic higher-educated workers in recent years didn't cause the overall returns to education to decline, based on the results we found in Chapter 2. As a simple demand-supply rule, if the relative labor demand were stable we would expect that the relative wages of those higher educated workers fell during this period. Similarly, the relative wages for women should fall as the women's labor participation rate increased, if the relative labor demand for women were stable during this period. Therefore, strong shifts in relative labor demand are necessary to explain this scenario. We expect that

Hypothesis 1: In order to maintain constant returns to college education, the relative demand for higher-educated workers should increase during this period. That is, the relative labor demand can't be constant or "stable" during this period.

From the analysis in Chapter 2, we also observed that those industries which are relatively more low-skilled intensive were also the industries that lost employment, and those industries which are relatively more high-skilled intensive were also the industries that gained employment. Therefore, it's expected that

Hypothesis 2: Between-industry and within-industry demand shifts away from lower educated workers were going to the same direction during this period. That is, they all indicated strong relative demand for higher-educated works.

Changes in relative labor demand could also arise from changes in international trade. Changes in patterns of international trade could be a possible source of product-demand shifts (Murphy and Welch (1991)), especially for Taiwan which international trade ratio to her GDP has risen since World War II. More than 50 percent of total workers in Taiwan were employed in trade sectors during the 1978-1996 period. We would expect that international trade played an important role in determining the relative demands for various demographic groups of labor. Many have believed that the increasing proportion of Taiwan's exports in high-tech electronic equipment would shift labor demand away from less-educated workers to higher-educated workers. Therefore, it's expected that

Hypothesis 3: The role of Taiwan's international trade would gradually favor higher-educated workers during this period.

The Theoretical Framework

Katz and Murphy (1992) examined the changes in relative supplies and relative wages for different demographic groups using a simple supply and demand model. The relative wages of different demographic labor inputs can be viewed as the interaction of the relative supplies of labor inputs and their demand functions. Assuming these labor inputs are not perfect substitutes, the shifts in relative supplies and relative demands will determine the equilibrium relative wage for each group.

Assuming the demand function is

$$X_t = D(W_t, Z_t) \tag{3.1}$$

where X_t is the $K \times 1$ vector of employed labor inputs at time t,

W_t is the $K \times 1$ vector of wages of these labor inputs at time t,

Z_t is the $m \times 1$ vector of demand shifters at time t.

Totally differentiating equation (3.1), we get

$$dX_t = D_W dW_t + D_Z dZ_t \tag{3.2}$$

Rearrange equation (3.2) and premultiply dW_t', we get

$$dW_t'(dX_t - D_Z dZ_t) = dW_t' D_W dW_t \tag{3.3}$$

Based on the assumption that the production function is concave,

$$D_W = \begin{bmatrix} \frac{\partial x_1}{\partial w_1} & \frac{\partial x_1}{\partial w_2} & \cdots & \frac{\partial x_1}{\partial w_K} \\ \frac{\partial x_2}{\partial w_1} & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ \frac{\partial x_K}{\partial w_1} & \cdots & \cdots & \frac{\partial x_K}{\partial w_K} \end{bmatrix}_{K \times K}$$ is negative semidefinite.

That is, the right hand side of equation (3.3) will be less than or equal to zero.

We then can test the hypothesis that labor demand is stable, i.e. $dZ = 0$, during a period by calculating $dW'dX = (W_t - W_\tau)'(X_t - X_\tau)$ between year t and year τ. If it turns out to be positive, then we will reject the hypothesis that only supply shifts are involved. In this case, demand side factors must play an important role when determining the relative wages of different demographic labor inputs.

Changes in Relative Supplies, 1978-1996

Table 3.1 shows the changes of log share of demographic labor inputs between 1978 and 1996. The relative supply here is measured by each demographic group's share of total labor supply. The labor supply data is created from the same household surveys mentioned in the last chapter. This time it includes all individuals aged 18-65 who are not in military services. Students still enrolled in school are excluded. Therefore, it includes self-employed and unemployed workers, and housekeepers.

The numbers in Table 3.1 illustrate that the relative supply of women has been growing over these three subperiods, while men are losing their share of total labor supply. Educational attainment of Taiwanese labor force continued to improve during the 1978-1996 period, and the share of workers with at least junior college degree, especially for the young (with 1-10 years of experience) increased dramatically because of the policy of higher education expansion starting in 1990. The time pattern of changes in relative supplies of these highly-educated workers might be able to clarify how the college premium changed during these three subperiods. The college wage premium for the young workers with 1-10 years of experience (Figure 2.4) increased during 1978-1984. But it decreased a little during 1984-1990 and sharply during 1990-1996.

Labor market share for workers with at least 31 years of experience decreased over the 1978-1996 period. The increase in the share of the young workers (1-5 years of experience) in the 1990's is associated with its higher labor force participation rate. From the table, we can also see the pattern of baby boom cohorts entered the labor force with 1-10 years of experience in 1978-1984, with 11-20 years of experience in 1984-1990, and with 21-30 years of experience in 1990-1996.

Table 3.1. Changes in Relative Supply, Taiwan, 1978-1996

	Changes in log share of labor input			
Demographic Group	1978-1984	1984-1990	1990-1996	1978-1996
Gender:				
Male	-0.067	-0.040	-0.063	-0.170
Female	0.108	0.057	0.079	0.244
Education:				
Primary or less	-0.124	-0.188	-0.255	-0.567
Junior high	0.099	0.126	-0.015	0.210
Senior high	0.168	0.170	0.128	0.466
Junior college	0.221	0.178	0.265	0.664
University or above	-0.006	0.084	0.252	0.330
Experience:				
1-5 years	0.144	0.008	0.096	0.248
6-10 years	0.097	-0.048	-0.086	-0.037
11-20 years	0.063	0.085	-0.044	0.104
21-30 years	-0.202	0.099	0.115	0.012
31-40 years	-0.136	-0.194	0.013	-0.317
41+ years	0.260	0.017	-0.097	0.180
Education and Experience:				
Primary or less				
1-10 years experience	-1.459	-1.303	-1.336	-4.098
31+ years experience	0.068	-0.113	-0.057	-0.102
Junior or Senior high				
1-10 years experience	0.273	-0.005	-0.164	0.104
31+ years experience	-0.105	-0.032	0.027	-0.110
Junior college or above				
1-10 years experience	0.016	0.014	0.244	0.274
31+ years experience	0.039	-0.109	0.000	-0.070

Source: Author's calculation.

Testing the "Stable Labor Demand" Hypothesis

To test the "Stable Labor Demand" Hypothesis, i.e. to see if $dW'dX \leq 0$, we follow the methodology from Katz and Murphy (1992) by dividing our data into 60 different demographic groups, distinguished by sex, 5 education levels (primary or less, junior high, senior high, junior college, and university or above), and 6 experience levels (1-5, 6-10, 11-20, 21-30, 31-40, and 41+ years). We calculate the inner products of changes in relative wages with changes in relative supplies for the 1978-1984, 1984-1990, 1990-1996, 1978-1990, 1984-1996, and 1978-1996 periods.

The upper part of Table 3.2 shows the results of inner product calculations. Except for the 1990-1996 period which has a very small negative value, all the other 5 periods have positive values, which suggests only the 1990-1996 period is consistent with the "Stable Labor Demand" Hypothesis. We can reject the hypothesis that relative wages are solely determined by relative supply shifts for the entire 1978-1996 period.

Indeed, Figures 3.1, 3.2, 3.3, and 3.4 show the plots of changes in log wages and log relative supplies for these 60 demographic groups for the 1978-1984, 1984-1990, 1990-1996, and 1978-1996 periods. We draw the predicted lines based on weighted least square regressions of the changes in log relative wages on the changes in log relative supplies. That is, we regress

$$Py = \begin{bmatrix} y_1/\sqrt{w_1} \\ y_2/\sqrt{w_2} \\ \cdot \\ \cdot \\ y_{60}/\sqrt{w_{60}} \end{bmatrix} \quad \text{on} \quad Px = \begin{bmatrix} x_1/\sqrt{w_1} \\ x_2/\sqrt{w_2} \\ \cdot \\ \cdot \\ x_{60}/\sqrt{w_{60}} \end{bmatrix},$$

Table 3.2 Inner Products of Changes in Relative Labor Supplies with Changes in Relative Wages for 60 Demographic Groups

Year	Inner products of actual changes
1978-1984	0.9524
1984-1990	0.7068
1990-1996	-0.0003
1978-1990	2.3017
1984-1996	0.5316
1978-1996	3.6245

Year	Inner products of changes in detrended data
1978-1984	-0.2055
1984-1990	-0.0860
1990-1996	-0.0731
1978-1990	-0.4695
1984-1996	-0.2994
1978-1996	-0.5888

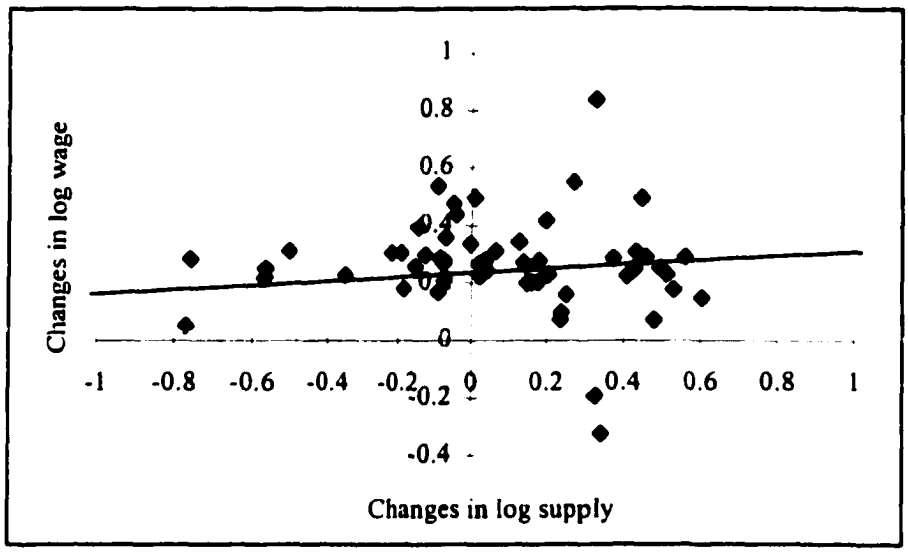

Figure 3.1 Changes in Wage and Supply for 60 Demographic Groups, 1978-1984

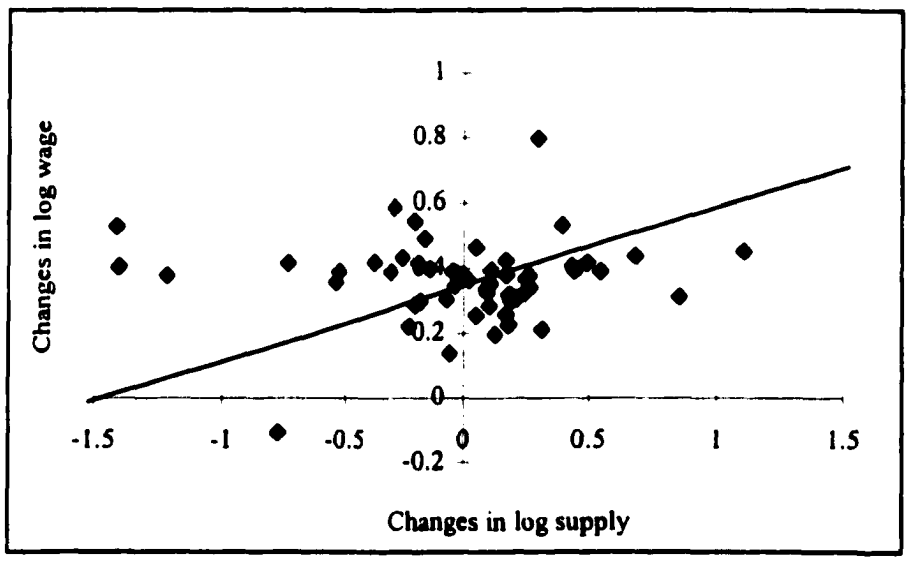

Figure 3.2 Changes in Wage and supply for 60 Demographic Groups, 1984-1990

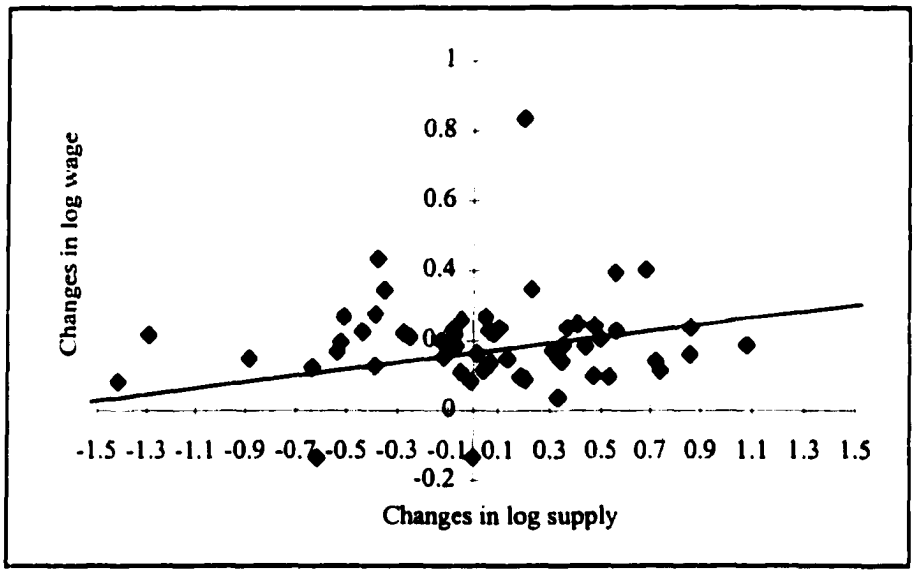

Figure 3.3 Changes in Wage and Supply for 60 Demographic Groups, 1990-1996

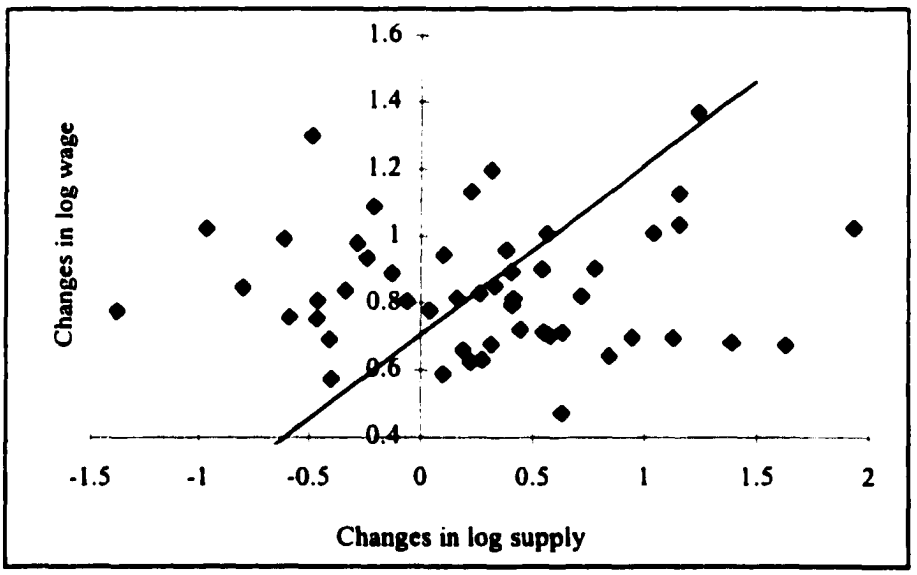

Figure 3.4 Changes in Wage and Supply for 60 Demographic Groups, 1978-1996

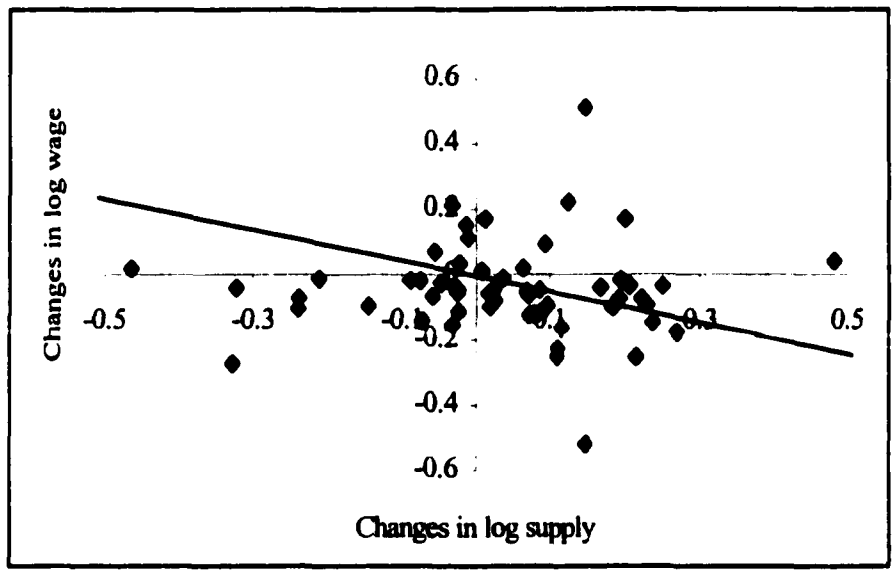

Figure 3.5 Changes in Detrended Wage and Supply for 60 Demographic Groups, 1978-1984

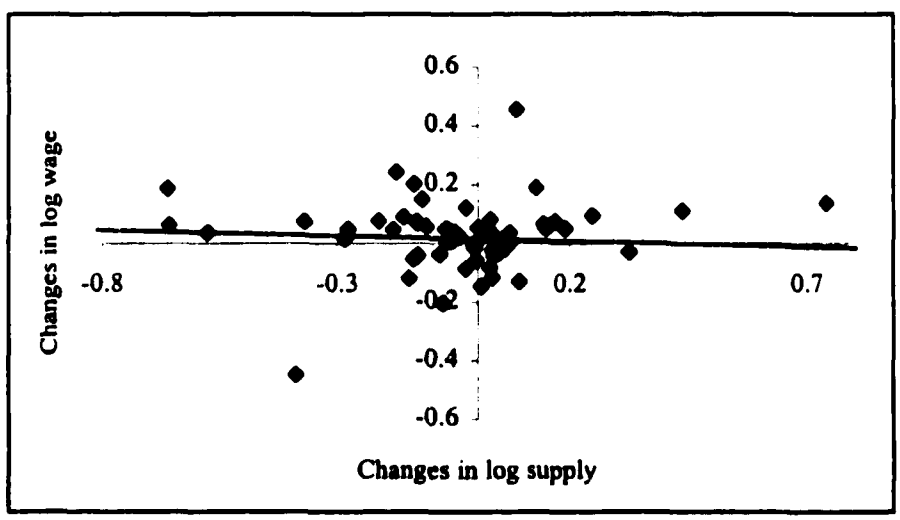

Figure 3.6 Changes in Detrended Wage and Supply for 60 Demographic Groups, 1984-1990

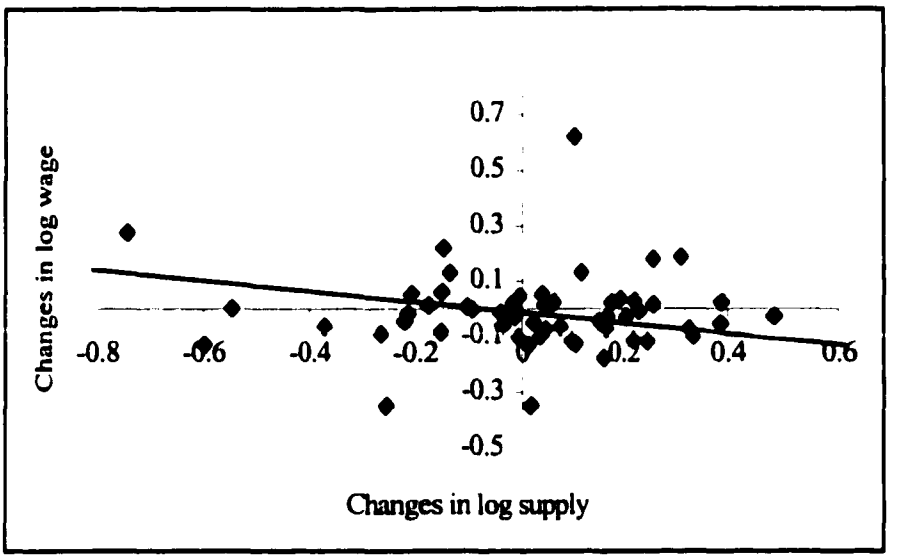

Figure 3.7 Changes in Detrended Wage and Supply for 60 Demographic Groups, 1990-1996

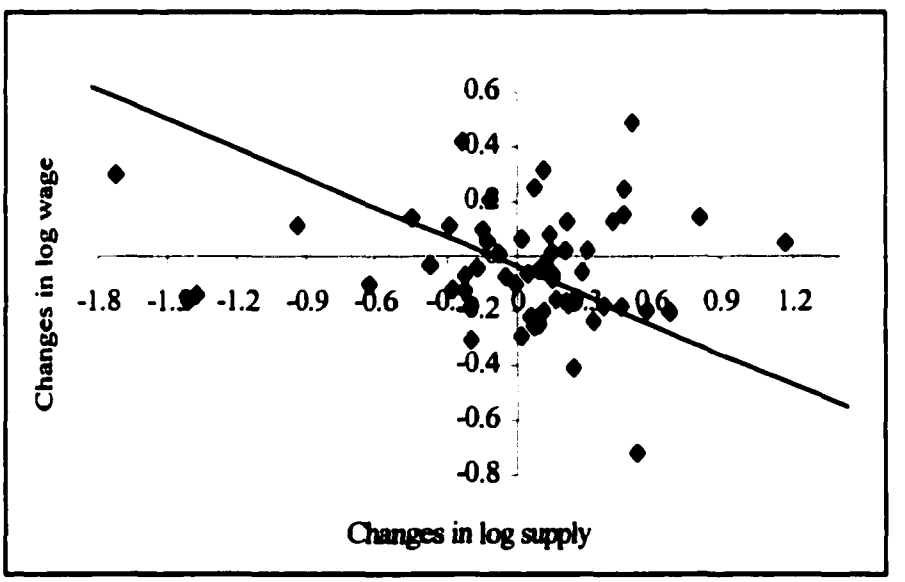

Figure 3.8 Changes in Detrended Wage and Supply for 60 Demographic Groups, 1978-1996

where $y_1, y_2, \ldots, y_{60}$ are the changes in log wages for the 60 demographic groups, $x_1, x_2, \ldots, x_{60}$ are the changes in log relative supplies for the 60 demographic groups, and the weights $w_1, w_2, \ldots, w_{60}$ are set to be the employment shares of each group in the initial period.

We then obtain the weighted least squares (WLS) estimator,

$$\hat{\beta}_w = \left(\sum_{i=1}^{60} \frac{1}{w_i} x_i x_i' \right)^{-1} \left(\sum_{i=1}^{60} \frac{1}{w_i} x_i y_i \right)$$

The use of weighting removes the dependence of the estimates on the sample design if the sample size is large enough (Dumouchel and Duncan (1983), Deaton (1997)).

All of the slopes of these 4 predicted lines from Figure 3.1 to Figure 3.4 are positive, meaning that there is a positive relationship between changes in relative wages and changes in relative supplies for these 60 demographic groups in the entire 1978-1996 period. This is consistent with the inner product results we calculated in the upper part of Table 3.2. It suggests that strong labor demand shifts through the entire 1978-1996 period were involved in determining the changes in relative wages.

Katz and Murphy (1992) found that trend demand growth alone can represent most of demand growth by skill during 1963-1987 for the U.S. labor market. In Taiwan, we not only consider time trend as an important source of demand shifts, but also GDP growth, international trade and the importation of low-skilled foreign workers, during the 1978-1996 period. We regress the time series of relative wages and of relative supplies for each of the 60 demographic groups on a constant, a time trend variable, and variables of real GDP, trade surplus and total number of foreign low-skilled workers in the year. Then we calculate the inner products in changes in the *detrended* relative wages and relative labor supplies also for the 1978-1984, 1984-1990, 1990-1996, 1978-1990, 1984-1996, and 1978-1996 periods. The

results are shown in the lower part of Table 3.2. All of the inner products become negative. Figures 3.5, 3.6, 3.7, and 3.8 show the plots of changes in *detrended* log wages and log relative supplies for the 60 demographic groups for the 1978-1984, 1984-1990, 1990-1996, and 1978-1996 periods. We also draw the predicted lines based on the weighted least square regressions like we did for Figures 3.1 - 3.4. All of the slopes become negative. This result is quite consistent to the *detrended* inner products in the lower part of Table 3.2.

Decomposition of Changes in the Relative Demand Shifts for Labor

Katz and Murphy (1992) described two types of labor demand shifts. The first occurs within industries, i.e. shifts that change the relative labor intensities within industries at fixed relative wages. This may happen due to factor non-neutral technological changes, changes in prices of non-labor inputs, and outsourcing. In the case of Taiwan, skill-biased technological changes within industries in favor of higher-educated workers, importing foreign low-skilled workers into Taiwan, and moving capital and factories out of Taiwan are potential industry-specific demand shifts away from lower-educated workers. The second type includes shifts that change the allocation of total labor demand between industries at fixed relative wages. This may be due to shifts in product demand across industries, different productivity growth between industries, and international trade. For example, changes in tastes toward higher quality products and increasing export of higher skill-oriented goods will shift the relative labor demand to higher-educated workers across industries.

The total labor demand shift is the sum of these two sources of demand shifts. To illustrate quantitatively how these two sources of demand shifts contribute to overall labor demand growth over time, we can decompose the growth of labor demand for those 5

different educational groups into between-industry and within-industry demand shift components. We are going to examine the employment of eight one-digit industries from 1978 to 1996. Following Autor, Katz, and Krueger's (1998) methodology, we can decompose the change in education group j's share of aggregate employment between years τ and t (ΔP_{jt}) into two terms (ΔP_{jt}^{b} and ΔP_{jt}^{w}).

$$\Delta P_{jt} = \sum_{k}(\Delta E_{kt}\gamma_{jk}) + \sum_{k}(\Delta\gamma_{jkt}E_{k}) \quad , \tag{3.4}$$

where $\Delta P_{jt} = P_{jt} - P_{j\tau}$, $\sum_{k}(\Delta E_{kt}\gamma_{jk}) = \Delta P_{jt}^{b}$, and $\sum_{k}(\Delta\gamma_{jkt}E_{k}) = \Delta P_{jt}^{w}$.

k is the industry index, and E_{jkt} is the employment of education group j in industry k in year t as a share of aggregate employment. $E_{kt} = \sum_{j} E_{jkt}$ is total employment in industry k in year t. $\gamma_{jkt} = E_{jkt} / E_{kt}$ is the education group j share of employment in industry k in year t. $\gamma_{jk} = (\frac{\gamma_{jkt} + \gamma_{jk\tau}}{2})$ is the average share of education group j in industry k between years t and τ, and $E_{k} = (\frac{E_{kt} + E_{kj}}{2})$ is the average employment of industry k between years t and τ.

By normalizing total employment in each year to one, ΔP_{jt}, ΔP_{jt}^{b}, and ΔP_{jt}^{w} become the indexes of the overall demand shift, between-industry demand shift, and within-industry demand shift respectively.

From Table 3.3 we can see the results of decompositions of overall demand shift index for the 5 educational groups in the periods of 1978-1984, 1984-1990, 1990-1996, and 1978-1996. The indexes of between-industry, within-industry and overall measure all indicate strong demand shift away from the lowest-education group to the higher-education

Table 3.3. Decomposition of Demand Shift Index, 1978-1996

	Between-Industry				Within-Industry				Total			
Group	78-84	84-90	90-96	78-96	78-84	84-90	90-96	78-96	78-84	84-90	90-96	78-96
Primary or less	-0.002	-0.013	-0.020	-0.035	-0.039	-0.066	-0.072	-0.177	-0.041	-0.079	-0.092	-0.212
Junior high	0.003	0.000	-0.005	-0.002	0.017	-0.002	0.023	0.038	0.020	-0.002	0.018	0.036
Senior high	0.001	0.010	0.008	0.019	0.029	0.026	0.078	0.133	0.030	0.036	0.086	0.152
Junior college	-0.002	0.004	0.008	0.010	0.015	0.026	0.055	0.096	0.013	0.030	0.063	0.106
Univ. or above	-0.004	0.004	0.010	0.010	0.005	0.022	0.021	0.048	0.001	0.026	0.031	0.058

Source: Author's calculation.

groups. The senior high school graduates gained the most in relative labor demand for the entire period, while workers with at least junior college degree also face increases in demand.

Workers with at least a junior college degree have benefited from both between-industry and within-industry demand shifts since the 1978-1984 period. In fact, the between-industry demand shift index for the highest-educated group declined in the 1978-1984 period, although the magnitude was quite small. The magnitude of these shifts has increased over time with more rapid increase for workers with only junior college degree than for workers with 4-year college degree for the entire 1978-1996 period. This may be due to strong expansion in manufacturing and construction industries which demanded a lot of middle-educated workers (junior high school, senior high school, and junior college graduates) during this period.

Comparing between-industry and within-industry demand shift indexes for these 5 educational groups, the major part of the increase or decrease in labor demand can be attributed to within-industry demand shifts over the entire period. It suggests that within-industry skill upgrading has been dominating the growth in demand for the higher-educated workers since 1978. This is similar to the case for U.S. labor market in the same period. Autor, Katz, and Krueger (1998) decomposed the demand shift of U.S. college graduates between 1960 and 1996. They also found that rapid skill upgrading within detailed industries (140 three-digit industries) accounted for most of the growth in relative demand for college workers since the 1970s.

The Relation between International Trade and Labor Demand in Taiwan, 1981-1996

Many past studies (Bluestone and Harrison (1988), Mincer (1991), Murphy and Welch (1989, 1991), Bound and Holzer (2000)) have analyzed the causes of change in the distribution of wages for the United States. Bound and Johnson (1992) reviewed four possible explanations for the large changes in the U.S. wage structure during the 1980's. The first is that increasing international trade may increase the relative demand for higher-educated workers and women through changes in the composition of demand. The second is that decreases in manufacturing employment and power of unions, causing the relative wages of lower-educated workers to decrease. The third is that technological changes, mainly from computers, is complementary with demand for skills. The last is that the slower pace of growth of college graduates may cause their relative wages to increase in this period. They concluded that the major cause was technological changes, although each of the other three also contributed slightly to the observed changes in relative wages.

As in the previous section, we found that changes in relative wages in Taiwan over the 1978-1996 period can't be explained by shifts in the relative labor supply curve alone. Strong labor demand shifts away from less educated groups toward more educated groups are found in the role of determining the changes in relative wages in this period. In this section, we are going to discuss the importance of Taiwan's international trade to the changes in relative labor demand. Because the ratios of exports and imports to Taiwan's GDP have been over 40 percent since the 1980's, we would expect that changes in international trade balance may be an important factor affecting relative labor demand. This is different from the case in the U.S. in that international trade only accounted for 11 to 14 percent of U.S. GDP in the 1980s (Murphy and Welch (1991)).

The trade data, published by Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan, Taiwan, includes the export values of agricultural, fishery, and forestry goods and manufacturing goods, and the import values of agricultural and manufacturing materials, capital equipment and consumption goods starting from 1981. Because the trade data does not match the employment data exactly, we aggregate the employment data into three groups. Industries Agriculture, Forestry and Fishery, Mining, and Manufacturing belong to "*traded goods*" sector, industries F.I.R.E. and Commerce belong to "*traded services*" sector, and industries Construction, Transportation, Electricity, Gas and Water, and Social and Personal Services are "*non-traded goods and services*" sector. In the trade data, consumption goods will be considered as traded services, while the others will be traded goods. The matching is shown in the Appendix E.

Table 3.4 shows the employment shares for various demographic groups in these sectors in 1981, 1990, and 1996. The employment share in the traded sectors (traded goods and traded services) was more than 50 percent of total employment. Employment share for traded goods decreased over time, while employment share for traded services increased over time. Women were disproportionately employed in the traded sectors, while men were concentrated in the non-traded sectors. Also, as the education levels increase, the proportion of employment in traded goods decreased. More educated labor was concentrated in traded services and the non-traded sectors.

Using the methodology in Murphy and Welch (1991), trade can be shown to have two effects on labor demand. The "composition effect" will increase employment demand in exporting industries if net exports increase. The "scale effect" will increase employment demand when an increase in imports causes an increase in aggregate spending and further

Table 3.4. Employment Shares of Traded Goods, Traded Services and Non-traded Goods Sectors in 1981, 1990, and 1996

	Traded Goods			Traded Services			Non-traded Goods and Services		
Group	1981	1990	1996	1981	1990	1996	1981	1990	1996
All	46.2	42.5	34.8	11.0	16.2	21.1	42.8	41.3	44.1
Gender									
Male	42.4	40.3	34.9	10.6	14.4	17.4	47.0	45.3	47.7
Female	54.8	46.4	34.6	12.0	19.4	26.5	33.2	34.3	38.9
Education									
Primary&less	60.3	55.3	46.1	5.1	6.5	9.5	34.7	38.2	44.4
Junior high	52.6	53.2	42.7	10.5	12.0	14.3	36.8	34.8	43.0
Senior high	39.3	38.7	35.0	17.0	24.0	26.4	43.6	37.4	38.6
Junior college	20.5	26.1	26.6	15.0	23.9	28.5	64.5	50.0	44.9
Univ.&above	15.4	16.7	15.7	19.1	20.5	26.3	65.5	62.9	58.0

Source: Author's calculation.

expansion of all sectors, assuming this effect is neutral to all sectors. So the full effect of changes in international trade on labor demand for group j can be represented as

$$\frac{dN_j}{N_j} = \sum_k \left(\frac{N_{jk}}{N_j}\right)\left(\frac{\Delta I}{Y} - \frac{dI_k}{Y_k}\right) \quad , \tag{3.5}$$

where N_j is the total employment of labor group j, and N_{jk} is the total employment of labor group j in sector k. I_k and Y_k are the net imports and GDP in sector k, respectively. $\Delta I = \sum_k dI_k$ is the change in aggregate net imports, i.e. trade deficit. If the country is

experiencing a trade surplus, then $\Delta I < 0$. The expression $(\frac{\Delta I}{Y} - \frac{dI_k}{Y_k})$ is the estimate (prediction) of change in labor demand in sector *k*.

By the definition, the value of I_k in the "non-traded goods and services" sector would be zero. Therefore, there is only the scale effect, $\frac{\Delta I}{Y}$, in the non-traded sector. Because Taiwan experienced increasing international trade surplus over the entire 1981-1996 period, the predictions of the trade effect on labor demand in the non-traded sector, based on $(\frac{\Delta I}{Y} - \frac{dI_k}{Y_k}) = \frac{\Delta I}{Y} < 0$, implies negative labor demand growth. The trade effects in traded sectors are positive in both periods. The right hand side of Table 3.5 shows the observed (actual) changes in employment in these three sectors with and without foreign workers. The predicted employment change in the traded goods sector is much larger than the observed increase, even when importation of foreign unskilled workers are taken into account. The employment level actually declined during 1990-1996 in this sector, despite the fact that many foreign workers filled these jobs. Demand shift from trade swamped by employment gains in other sectors. On the other hand, in traded services and non-traded goods and services sectors, the observed growth is much larger than that predicted from the trade effect. Murphy and Welch (1991) mentioned that the strong trend in services sectors and imprecise match between the trade data and employment data might be the reasons.

We now turn to the trade effects on various demographic groups. Using equation (3.5), we calculate the relative demand shifts from trade effects over the 1981-1990 and 1990-1996 periods. Table 3.6 shows the trade effect and observed changes of labor demand for these two periods. We can see that trade effects predict relative demands for all various

Table 3.5 Predicted and Observed Employment Changes (%) by Sector, 1981-1996

	Predicted[a]		Observed[b]		
Sector	1981-1990	1990-1996	1981-1990	1990-1996[c]	1990-1996[d]
Traded Goods	23.3	7.5	7.6	-10.2	-5.7
Traded Services	3.0	11.8	56.2	27.9	27.9
Non-traded Goods and Services	-10.2	-0.6	32.8	24.0	27.3

a. equals $(\frac{\Delta I}{Y} - \frac{dI_k}{Y_k})$.

b. equals $(\frac{dN_k}{N_k})$.

c. not including foreign workers.

d. including foreign workers. Foreign workers were employed in manufacturing (traded goods), construction and social and personal services (non-traded goods and services).

demographic groups increase in both periods except for a small reduction for the highest-educated group in the 1981-1990 period. In the 1981-1990 period, the relative demand for the lower-educated groups was much larger than the higher-educated groups, based on the trade effect. While the difference is smaller in the 1990-1996 period, the estimates show that trade has traded to favor the least-educated. Thus trade has traded to mitigate factors that have lowered demand for low-skilled labor in other countries. Taiwan was beginning to change from exporting cheap labor goods to exporting high-tech goods in the 1990's, such as personal computers and electronic equipment, but the trade balance still favored low-skilled labor through the mid-1990s.

Table 3.6 Predicted and Observed Employment Changes (%) by Demographic Group, 1981-1996

	Predicted[a]		Observed[b]		
Group	1981-1990	1990-1996	1981-1990	1990-1996[c]	1990-1996[d]
All	6.4	4.8	24.1	9.5	12.5
Gender					
Male	5.3	4.4	16.3	6.4	~
Female	8.8	5.5	39.7	14.5	~
Education					
Primary&less	9.9	4.5	-15.2	-33.9	-17.4
Junior High	9.0	4.9	28.7	6.7	14.3
Senior High	5.6	5.5	82.1	25.2	25.2
Junior College	0.2	4.8	101.6	53.3	53.3
Univ.&above	-2.2	3.6	70.3	44.0	44.0

a. equals $\sum_k (\frac{N_{jk}}{N_j})(\frac{\Delta I}{Y} - \frac{dI_k}{Y_k})$.

b. equals $\sum_k (\frac{N_{jk}}{N_j})(\frac{dN_k}{N_k})$.

c. not including foreign workers.

d. including foreign workers. Foreign workers are considered as junior high school educated or below. We divide the total number of foreign workers equally into Primary&less and Junior High groups.

Both predicted and observed employment changes favor women. The magnitude of the observed advantage for women in employment growth is much larger than that predicted by trade flows, indicating that trade has a minor role in explaining the increase in women's employment share.

Conclusion

The results found in this chapter are generally consistent with most previous literature which was done for the United States. Using the methodology from Katz and Murphy (1992), we calculate the inner products of $dW'dX$ for different subperiods and find most of them being positive, which means "Stable Labor Demand" Hypothesis should be rejected during this period. That is, the relative wages can't be solely determined by relative supply shifts during the entire 1978-1996 period. After *detrending* the relative wages and supplies by regressing them on time trend, GDP, trade surplus, and number of foreign workers, we find all of *detrended* inner products become negative. We infer that the sources of strong relative demand shifts during this period could be associated to trend growth (for example, technological changes), international trade, and the importation of foreign low-skilled workers.

The results from decomposition of changes in relative labor demand shifts show strong demand shift away from the least-educated group to the more educated groups in both between-industry and within-industry measures. However, within-industry demand shift played a more important role in demanding higher-educated workers during this period. This leads us to accept the Hypothesis 2 stated earlier in this chapter.

The effect of international trade on relative labor demand shift in Taiwan during this period was found consistently with the Hypothesis 3. Although the trade effect still favored lower-educated workers through the mid-1990s, it has gradually shifted to higher-educated workers since 1990, mainly because of the changes in composition of export goods. The trade effect also predicted strong demand for women relative to men during the entire 1981-

1996 period. However, trade alone might not be enough to explain the strong relative demand for women during this period.

CHAPTER 4

THE EFFECTS OF TEMPORARY FOREIGN UNSKILLED WORKERS ON OUTCOMES OF TAIWAN LABOR MARKET

The extent to which foreign unskilled workers have displaced local unskilled workers has been widely debated in academic and government circles. Table 4.1 reports the unemployment rates by education level. Unemployment rates for workers with less than a high school education were quite low relative to those workers with high school education or more. There was no obvious disproportionate increase in relative unemployment for the least educated after the foreign unskilled workers started entering the Taiwan labor market in 1991. Unemployment rose for all education groups. However, according to Simon (1989), the extent of "displacement" can't be determined simply by observing whether immigrants are "occupying" jobs or immigrants are working at wages that do not attract sufficient local workers to take the jobs.

Foreign unskilled workers might be expected to be substitutes for local less educated workers but complements for local higher educated workers. If true, then importation of foreign unskilled workers would be expected to reduce the wages and increase the unemployment rates for local unskilled workers, but increase the wages and reduce the unemployment rates for local skilled workers. Table 4.2 shows the results from past studies which estimate the impacts of immigrants on the wages and employment of various groups of U.S. and German native workers. Most empirical studies found little correlation between unemployment and immigration in the U.S. and Europe (Simon and Moore (1984), Borjas (1987), De New and Zimmermann (1994, 1995), Friedberg and Hunt (1995)). Zimmermann

Table 4.1. Unemployment Rates (%) by Educational Attainment in Taiwan, 1978-1996

Year	Primary&less	Junior high	Senior high	Junior college	Univ.&above
1978	0.53	2.28	3.65	3.75	2.54
1979	0.36	1.62	2.80	2.66	1.86
1980	0.32	1.45	2.62	2.51	1.93
1981	0.37	1.69	2.72	2.57	1.86
1982	0.72	2.66	3.81	3.46	2.78
1983	1.02	3.07	4.69	4.60	3.42
1984	0.87	2.59	4.27	3.99	3.46
1985	1.07	3.13	4.78	4.68	3.65
1986	0.90	2.85	4.41	3.99	3.49
1987	0.62	2.08	3.28	2.96	2.44
1988	0.53	1.77	2.33	2.60	2.06
1989	0.47	1.62	2.45	2.31	1.85
1990	0.46	1.73	2.50	2.46	2.03
1991	0.44	1.61	2.16	2.23	1.85
1992	0.41	1.52	2.13	2.05	2.28
1993	0.36	1.38	1.91	2.25	2.07
1994	0.46	1.53	1.98	2.12	2.38
1995	0.57	1.80	2.25	2.35	2.52
1996	1.24	2.77	3.00	3.14	3.13

Source: Yearbook of Manpower Survey Statistics, Taiwan, 1997.

Table 4.2. Previous Studies: The Impacts of Immigrants on Native Wages and Employment

Study	Native wage elasticity with respect to immigrants	Native employment elasticity with respect to immigrants
Grossman[a] (1982)	-0.02	
DeFreitas and Marshall[b] (1984)	-0.004	
Simon and Moore[c] (1984)		0
Borjas[d] (1986)	-0.02 to -0.01	
Borjas[e] (1987)	-0.03 to +0.02	-0.01 to +0.04
Altonji and Card[f] (1990)	+0.02 to +0.05	-0.03 to -0.01
LaLonde and Topel[g] (1990)	-0.01	
LaLonde and Topel[h] (1990)	-0.03 to +0.02	
De New and Zimmermann[i] (1994)	-0.059	0
De New and Zimmermann[j] (1994)	+0.035	0
Jaeger[k] (1996)	-0.15 to -0.30	
Bratsberg[l] (1996)	-0.14	

Source: Borjas (1990), Zimmermann (1995), and Hamermesh and Bean (1998).

[a]: All U.S. natives.
[b]: U.S. manufacturing workers.
[c]: All U.S. natives.
[d]: U.S. white men.
[e]: U.S. black men.
[f]: U.S. women.
[g]: U.S. young blacks.
[h]: U.S. young Hispanic.
[i]: German blue-collar workers.
[j]: German white-collar workers.
[k]: U.S. high school dropouts.
[l]: U.S. black men.

(1995) even found a negative but statistically insignificant relationship between the unemployment rate and the share of foreign population for the individual countries in the European Union, for the European Union as a whole, for the United States and for Japan. Altonji and Card (1991) analyzed the effects of immigrants on the labor market outcomes for the U.S. less skilled workers over the 1970-1980 period. Although there is evidence of some displacement of natives out of low-wage immigrant-intensive industries, they found no effect of increased immigration on employment rates and a small negative effect on wages of low-skilled domestic workers. De New and Zimmermann (1994) showed that immigration reduced wages of German blue-collar workers and increased wages of white-collar workers in the 1980s.

The Impact of Foreign Workers on Native Earnings

As the previous studies demonstrate, the effects of immigration on low-skilled employment and wages may be different for different countries. Foreign unskilled workers have been found to be substitutes or complements for local unskilled workers. To analyze this issue empirically for the Taiwan labor market, we prepare an inverse input demand formulation in which foreign unskilled workers enter the Taiwanese workers' earnings equation.

$$\ln W_{i\tau} = h(x_i, GDP_{i\tau}, I_{i\tau}, \sum_{t=0}^{\tau} I_{it}) \ , \tag{4.1}$$

where $\ln W_{i\tau}$ is the logarithm of the ith individual's annual wage in year τ, $x_{i\tau}$ is a vector of individual i's human capital characteristic variables, and $GDP_{i\tau}$ is the sectoral GDP in year τ for the industry that the ith individual belongs to. $I_{i\tau}$ is the quota on foreign unskilled

workers imported in year τ in the ith worker's industry, and $\sum_{t=0}^{\tau} I_{it}$ is the accumulated sum of past and current quotas on foreign unskilled workers imported in the industry where the local worker is working.

The specification allows for different effects of foreign labor on local skilled and unskilled workers. Let S equal 1 if the individual is skilled (at least junior college graduate), and 0 if the individual is unskilled (with less than junior college education). The coefficients on $S \times I$ and $(1-S) \times I$ can be interpreted as the short-run effects of importing temporary foreign unskilled workers on the wages of local skilled and unskilled workers respectively. The coefficients on $S \times \sum I$ and $(1-S) \times \sum I$ can be interpreted as the cumulative effects of importing temporary foreign unskilled workers on the wages of local skilled and unskilled workers respectively. The sectoral GDP entering the earnings equation will capture the effects of trade and cyclical changes in aggregate demand.

The OLS (Ordinary Least Square) regression result is shown in Table 4.3. In specification (1), which separates current quota from past accumulated quota, the estimates imply that foreign unskilled workers are not only complements for domestic skilled workers, but are also complements to domestic unskilled workers. However, the results show the impacts on domestic workers' wages are quite small. If there is a 10 percent increase in the number of imported foreign unskilled workers in a year, the wages of domestic unskilled and skilled workers will increase only by about 0.2 percent and 0.6 percent respectively. The results also show the foreign unskilled workers are not equally beneficial to domestic unskilled and skilled workers in which the sum of the coefficients on $S \times I$ and $S \times \sum I$ is

not equal to the sum of the coefficients on $(1-S)\times I$ and $(1-S)\times \sum I$. The hypothesis that these two sums are equal is rejected at 5 percent confidence interval. Specifications (2) and (3) also show the similar results. Both the hypotheses that the coefficient of $S\times I$ is equal to the coefficient of $(1-S)\times I$ in specification (2) and the coefficient of $S\times \sum I$ is equal to the coefficient of $(1-S)\times \sum I$ in specification (3) are rejected at 5 percent confidence interval. Also, the coefficients on variables $S\times GDP$ and $(1-S)\times GDP$ in the three specifications all indicate that the shifts in GDP favored the skilled workers during this period. The hypotheses that these two coefficients are equal are all rejected in the three specifications.

The Impact of Foreign Workers on Native Employment

Next we turn to analyze the impact of foreign workers on local workers' employment. As we mentioned earlier, unemployment rates did not rise disproportionately for local skilled or unskilled workers since the Taiwanese government began to bring foreign workers into Taiwan labor market in 1991. We can't really see the impact only based on the trend in Table 4.1.

The methodology used to estimate the employment effect of foreign workers is different from the one used for measuring the wage effects. Here the pooled cross section-time series data from 1978 to 1996 is used in the OLS regression equation:

(4.2) $$UR_{jt} = \alpha_0 + \alpha_1 Q_{jt} + \alpha_2 Y_{jt} \ ,$$

where UR_{jt} is the unemployment rate for education group j at year t, Q_{jt} and Y_{jt} are the weighted logs of foreign labor quota and GDP for education group j at year t. The weighting

is described as follows. For education group j, $Q_j = \sum_{i=1}^{n} s_i^j q_i$ and $Y_j = \sum_{i=1}^{n} s_i^j y_i$, where s_i^j is the proportion of education group j in sector i, q_i is the number of foreign workers in sector i, and y_i is the GDP in sector i. The result is shown in the first column of Table 4.4.

The alternative way is to add dummy variables to differentiate each education group in the regression equation. The result is shown in the second column of Table 4.4.

As Table 4.4 shows, foreign workers have a negligible effect on local workers' unemployment rate. The estimate in column one shows a positive coefficient of 0.004. This implies that 10 percent increase in the foreign worker share increases the unemployment rate by 0.04 percent. However, the effect is statistically insignificant. The estimates in column two show the similar implication. None of the groups of local workers is significantly affected by the foreign workers.

Conclusion

Since the Taiwanese government started importing foreign unskilled workers in 1991, many people have expressed concerns that importation of foreign unskilled workers would displace Taiwan's domestic unskilled workers and cause their earnings to decline. In contrast, the results found in this chapter show that an increase in number of foreign unskilled workers has little effect on the change in employment and annual earnings for both domestic skilled and unskilled workers. This suggests that the policy of importing foreign unskilled workers would increase domestic workers' welfare in that it will prevent those companies which suffer labor shortages from moving abroad or shutting down, and increase their motivation to invest more in Taiwan and further increase labor demand for domestic

skilled and unskilled workers. That is, foreign unskilled workers tend to be complements for both domestic skilled and unskilled workers in long run. The Taiwanese government seems successfully implementing this policy and increasing economic growth and welfare in terms of GDP and workers' earnings.

Table 4.3. The Effects of Foreign Unskilled Labor on Domestic Workers' Wages, 1978-1996

Variables	(1)	(2)	(3)
Constant	10.628*	10.445*	10.446*
	(683.6)	(752.2)	(752.1)
JuniorHigh	0.2347*	0.2273*	0.2271*
	(44.53)	(43.65)	(43.61)
SeniorHigh	0.5035*	0.4960*	0.4962*
	(106.35)	(106.04)	(106.10)
JuniorCollege	0.2357*	0.3650*	0.3637*
	(8.12)	(14.67)	(14.60)
Univ.	0.4413*	0.5751*	0.5743*
	(15.50)	(23.61)	(23.54)
Experience	0.0539*	0.0540*	0.0540*
	(103.31)	(104.90)	(104.90)
Experience^2	-0.0008*	-0.0008*	-0.0008*
	(-79.54)	(-80.50)	(-80.50)
Male	0.3211*	0.3327*	0.3320*
	(89.98)	(94.49)	(94.28)
$S \times GDP$	0.1550*	0.1678*	0.1681*
	(36.66)	(45.42)	(45.39)
$(1-S) \times GDP$	0.0674*	0.1005*	0.1003*
	(31.26)	(51.24)	(51.17)
$S \times I$	0.0598*	0.0252*	
	(13.36)	(27.09)	
$S \times \sum_{t=0}^{t-1} I$	-0.0323*		
	(-6.82)		

Note: The values in parentheses are the t-statistics.
The dependent variable and the quotas are in natural logarithms.
* Statistically significant at 5 percent confidence interval.

Table 4.3.(continued)

$S \times \sum_{i=0}^{r} I$			0.0231*
			(26.55)
$(1-S) \times I$	0.0248*	0.0335*	
	(9.58)	(66.14)	
$(1-S) \times \sum_{i=0}^{r-1} I$	0.0143*		
	(5.38)		
$(1-S) \times \sum_{i=0}^{r} I$			0.0311*
			(66.32)
R^2	0.4174	0.4318	0.4317

Table 4.4. The Effects of Foreign Unskilled Labor on Domestic Workers' Unemployment Rate, 1978-1996

Variables	(1)	(2)
Constant	8.636*	1.112
	(3.73)	(0.29)
JuniorHigh		5.513
		(1.00)
SeniorHigh		9.558**
		(1.80)
JuniorCollege		7.904
		(1.58)
Univ.		5.855
		(1.17)
Weighted Quota	0.004	-0.008
	(0.09)	(-0.15)
J.High × Weighted Quota		-0.006
		(-0.08)
S.High × Weighted Quota		-0.048
		(-0.63)
J.College × Weighted Quota		-0.015
		(-0.18)
Univ. × Weighted Quota		0.049
		(0.58)
Weighted GDP	-0.985*	-0.065
	(-2.65)	(-0.11)

Note: The values in parentheses are the t-statistics.
The dependent variable is unemployment rate × 100.
The weighted quota and GDP are in natural logarithms.
* Statistically significant at 5 percent confidence interval.
** Statistically significant at 10 percent confidence interval.

Table 4.4 (continued)

J.High × Weighted GDP		-0.609 (-0.70)
S.High × Weighted GDP		-1.069 (-1.28)
J.College × Weighted GDP		-0.869 (-1.09)
Univ. × Weighted GDP		-0.662 (-0.81)
R^2	0.154	0.741

CHAPTER 5

SUMMARY AND CONCLUSION

This dissertation analyzes the roles of education policy, trade, and immigration on the changes of wages and employment by skill in Taiwan during the 1978-1996 period. Chapter 1 introduced the background of Taiwan labor market and the problem of labor shortages among most of the Taiwanese manufacturing companies during this period. Major education policy that dramatically increased the number of college graduates was also described in Chapter 1. Chapter 2 first described the sources of data used in this dissertation and its sample statistics. Then using the data set, we analyzed the changes of relative employment and relative wages by industry, education level, experience, and gender during the 1978-1996 period. The changes of female-male earnings gap and earnings inequality between and within skill groups were also explored here. Chapter 3 stated the hypotheses needed to be tested after observing the stylized facts in Chapter 2 and presented a simple supply and demand model for examining the changes in relative supplies and wages of various demographic groups. This model was used to test the "Stable Labor Demand" Hypothesis by calculating the inner products of changes in relative supplies and wages during a period. We then decomposed the relative labor demand shifts into between-industry and within-industry demand shifts. The results were shown in this chapter. The role of international trade on the changes in relative labor demand during the 1981-1996 period was also analyzed in this chapter. Chapter 4 focused on the effects of foreign unskilled workers on changes of employment and wages for both domestic skilled and unskilled workers.

The Changes of Relative Employment and Wages, 1978-1996

We used the 1978, 1981, 1984, 1987, 1990, 1993, and 1996 editions of the Taiwan "Survey of Family Income and Expenditure". The results show that the relative employment declined for the lower-educated workers and rose for the higher-educated workers in this period, while the returns to education for all workers generally remained unchanged. However, the college premium decreased over time for the young (1-10 years of experience) particularly after 1990.

The relative employment and wages for women increased dramatically during this period, especially for the higher-educated women. Consequently, the female-male earnings gap narrowed during this period. Only some of this reduction came from narrowing skill differences between men and women. Most of the narrowing differential is due to "unexplained" factors, and the contribution of this "unexplained" part to the reduction of female-male earnings has been increasing over this period. These results are consistent with declining discrimination against women.

The results on earnings inequality were quite consistent with past literature that indicated Taiwan had low earnings inequality compared to developed and developing countries. The inequalities within most demographic groups have been decreasing over time.

The Role of Education Policy

As we mentioned earlier, the college premium for all workers remained unchanged but declined over time for those workers with 1-10 years of experience. The decline can be interpreted as an evidence that the educational reform policy, which increased the number of

4-year colleges and the relative supply of college graduate workers, has been reducing the quality of college education.

The reason for the decrease in returns to education for the least experienced in Taiwan is not quite the same as in the U.S. in the 1970s, when there also was a remarkable drop in the real and relative salaries of college graduates. Freeman (1976) pointed out that the relative returns to college were stable before the 1970s because of favorable changes in the industry mix of jobs and because of relatively small increases in the supply of college graduates. In the 1970s demand began to level off while supply increased rapidly, causing salaries and job opportunities to decrease. He concluded that people were actually overinvesting in college education and more American were becoming overeducated during the 1970s. In Taiwan, the demand for higher educated workers was still strong during this period. Poorer average quality of new four-year colleges may have caused new college graduates becoming to be less skilled over time. College education does not necessarily guarantee skills, and new and experienced college graduates do not appear to be close substitutes. Consequently, the increase in supply of college graduates has lowered earnings for new college graduates but not for experienced college graduates.

The Role of International Trade

Changes in trade flows went in the same direction as movements of relative labor demand except for the lowest-education group during this period. The trade effect predicted strong relative demand for the lower-educated workers and a relatively smaller demand for the higher-educated workers for the entire 1981-1996 period. The magnitude of difference in

both labor demands decreased over time. The trade effect also showed strong demand for women relative to men during the 1981-1996 period.

The trade effect, which still favored the least-educated workers in Taiwan, could be one of the reasons that caused Taiwan's trading partners to reduce their demand for low-skilled workers. Katz and Murphy (1992) concluded that the adverse effects of international trade on relative labor demand for the U.S. (Taiwan's largest exporting country) were concentrated on high school dropout workers, especially when the trade deficits expanded during the 1980s.

The Role of Immigration

Recent concern over the policy to allow unskilled foreign labor to work in Taiwan centered on whether immigrants have a significant adverse effect on domestic workers' earnings and employment opportunities. In particular, less-skilled natives would be expected to face the largest adverse effects.

This empirical evidence does not support the contention that foreign unskilled workers crowd domestic Taiwanese out of the labor market. The unemployment rate of domestic low-skilled workers did not increase after the importation of foreign unskilled workers began. Instead, we found negligible effect on both domestic skilled and unskilled employment. The increase in foreign workers even increased wages of both types of domestic workers, although the effect was quite small.

The results provide at least partial support for contribution of the government policy to import foreign unskilled workers as long as the problem of labor shortages persists.

Admission of foreign unskilled workers appears to strengthen overall economic growth that would have been retarded otherwise.

APPENDIX A: EMPLOYMENT SHARES OF FOREIGN WORKERS BY SECTOR

Table A.1 Employment Shares of Foreign Workers by Sector, 1991-1996

Sector	1991	1992	1993	1994	1995	1996
Manufacturing	~ 0.0%	0.3%	2.9%	4.2%	5.4%	6.5%
Construction	0.4%	0.9%	2.0%	3.3%	4.0%	5.0%
Services	~ 0.0%	~ 0.0%	0.7%	1.1%	1.4%	2.3%

Source: DGBAS, Executive Yuan, Taiwan (1997).

APPENDIX B: QUESTIONNAIRE FORM FOR SURVEY

Questionnaire Form

Name of sampling householder: Address:
Name of household head:

Standard Classifications of Statistical Area Ti'un or Li Code																			

City or Hsien		Urbanization		Serial No. of First Sample			No. of Sample Household		

Classification of Sampling Farm Household		
1. Farm household 2. Non-farm household	Grouped by Co-likvested land	Grouped by full time or not

Interview Status

1. Original sampled registered household
Reason for substitution:
2. The sample registered household changing register to other address.
3. The sample registered household not living at the registered address.
4. Nobody at home
5. Refused
6. Address not existed
7. Other:

1. Household Member

Item		Members living in the household														Members living outside with the same household register as household head			
		With the same household register as the household head										With different household register to the household head							
Member code		1	2	3	4	5	6	7	8	9	10	31	32	33	34	51	52	53	54
Name																			
Relation to the household head																			
Sex																			
Age																			
	Educational attainment																		
	Graduate or not																		
Full time	public sector or not																		
	Industry																		
	Occupation																		
Part time																			
Socio-economic status																			
Employment status																			
Employment or not																			
Income recipient or not																			
Place of work																			
Married status																			
National health insurance	No. of outpatient																		
	Days of hospital stay																		
	Insured Persons status																		
	Who paid the premium																		
	Premium																		
Social insurance (I)	Insured Persons status																		
	Insured month																		
Social insurance (II)	Insured Persons status																		
	Insured month																		

2. Household Equipment

Equipment	Amount	Equipment	Amount	Equipment	Amount
1. Color TV set		11. Answering machine		21. Dishwasher	
2. Laser disk player		12. Fax machine		22. Exhaust fan	

Equipment	Amount	Equipment	Amount	Equipment	Amount
3. Movie camera		13. Motor		20. Vacuum cleaner	
4. Stove		14. Sedan vehicle		24. Organ	
5. Piano		15. Motor bicycle		25. Hot-warm water fountain	
6. Video game		16. Electro-magnetic oven		26. Microwave oven	
7. Video tape recorder		17. Air conditioner		27. Newspaper	
8. Cable TV		18. Dehumidifier		28. Magazine	
9. Personal computer		19. Washing machine		Total Amount	
10 Telephone		20. Drier			

3. Housing

(1) Tenure of dwelling	Self-owned	Rented	Issued	Leased & others
(2) Usage of dwelling	Independent	Connected	Others	
(3) Style of building	One story	Two or three stories	Four or five stories	Six stories or over
(4)Piped water equipment	possessed of	Not possessed of		
(5)Self-owned house loans	Having house loans	None		
(6)Parking lot	Self-owned	Rented	None	
(7)Room and area	Housing land area (ping):	Total room area (ping):		

4. Income and Outlay

Part A:

Unit: NT$

Income recipient Serial No. and amount Item	Household head 1		2	3	4	5	6	7	8	Household income can not be taken apart to former income earning	Sub-total amount
Code of member in household	101		102	103	104	105	106	107	108	109	110
1. Compensation of employees	111		112	113	114	115	116	117	118	119	120
(1) Full time payroll	211		212	213	214	215	216	217	218	219	210
(2) Part time and spare time payroll	221		222	223	224	225	226	227	228	229	220
a. Retirement pay	131		132	133	134	135	136	137	138	139	130
b. Other part time payroll	141		142	143	144	145	146	147	148	149	140
(3) Other receipts or subsidies	231		232	233	234	235	236	237	238	239	230
a. Overtime pay	111		112	113	114	115	116	117	118	119	110
b. Awards	121		122	123	124	125	126	127	128	129	120
c. Insurance of OIL, LI, & HI by employers	131		132	133	134	135	136	137	138	139	130
d. Insurance of NHI by employers	791		792	793	794	795	796	797	798	799	790
e. Prizes & death benefits	141		142	143	144	145	146	147	148	149	140
2. Entrepreneurial income	241		242	243	244	245	246	247	248	249	240
(1) Agricultural & livestock income	261		262	263	264	265	266	267	268	269	260
(2) Net forest income	271		272	273	274	275	276	277	278	279	270
(3) Net fishing income	281		282	283	284	285	286	287	288	289	280
(4) Net operation surplus	291		292	293	294	295	296	297	298	299	290
(5) Net professional income	231		232	233	234	235	236	237	238	239	230
3. Property income	331		332	333	334	335	336	337	338	339	330
(1) Interest income	341		342	343	344	345	346	347	348	349	340
(2) Investment income	351		352	353	354	355	356	357	358	359	350
(3) Others	361		362	363	364	365	366	367	368	369	360
4. Imputed rent income	371		372	373	374	375	376	377	378	379	370
5. Current transfer receipts	481		482	483	484	485	486	487	488	489	480
(1) From individuals	491		492	493	494	495	496	497	498	499	490
(2) From government	491		492	493	494	495	496	497	498	499	490

a. Low income household	301		302	303	304	305	306	307	308	309			309	
b. Old-age allowance	311		312	313	314	315	316	317	318	319			319	
c. Old-age farmer subsidy	321		322	323	324	325	326	327	328	329			329	
d. Insurance of CEI, LI, A & FHI by government	331		332	333	334	335	336	337	338	339			339	
e. Insurance of NHI by government	341		342	343	344	345	346	347	348	349			349	
f. Others	351		352	353	354	355	356	357	358	359			359	
(2) Benefit of social insurance	361		362	363	364	365	366	367	368	369			369	
a. Benefit of CEI, LI, FHI, and SI	371		372	373	374	375	376	377	378	379			379	
b. Benefit of NHI	381		382	383	384	385	386	387	388	389			389	
(3) From enterprises	391		392	393	394	395	396	397	398	399			399	
a. Cash benefit of life and casualty insurance	401		402	403	404	405	406	407	408	409			409	
b. Others	411		412	413	414	415	416	417	418	419			419	
(4) From abroad	421		422	423	424	425	426	427	428	429			429	
(5) Miscellaneous receipts	431		432	433	434	435	436	437	438	439			439	
Total receipts	441		442	443	444	445	446	447	448	449			449	

Part B:

Unit : NT$

Income recipient Serial No. and amount Item	Household head 1	2	3	4	5	6	7	8	Household income can not be taken apart to former income recipient	Sub-total amount
1. Interest	501	502	503	504	505	506	507	508	509	509
(1) Home loan	511	512	513	514	515	516	517	518	519	519
(2) Others	521	522	523	524	525	526	527	528	529	529
2. Current transfer expenditures	541	542	543	544	545	546	547	548	549	549
(1) To private	571	572	573	574	575	576	577	578	579	579
a. Expenditure of marriage, birth and funeral	581	582	583	584	585	586	587	588	589	589
b. Charities	171	172	173	174	175	176	177	178	179	179
c. Others	181	182	183	184	185	186	187	188	189	189
(2) To government	591	592	593	594	595	596	597	598	599	599
a. House tax and land tax	501	502	503	504	505	506	507	508	509	509
b. Income tax	511	512	513	514	515	516	517	518	519	519
c. Other direct tax	521	522	523	524	525	526	527	528	529	529
d. Others	531	532	533	534	535	536	537	538	539	539
(3) Social insurance	541	542	543	544	545	546	547	548	549	549
a. Expenditure on CEI	551	552	553	554	555	556	557	558	559	559
b. Expenditure on LI	561	562	563	564	565	566	567	568	569	569
c. Expenditure on Farmer's health insurance	571	572	573	574	575	576	577	578	579	579
d. Expenditure on Fisherman's health insurance	581	582	583	584	585	586	587	588	589	589
e. Expenditure on SI	501	502	503	504	505	506	507	508	509	509
f. Expenditure on NHI	511	512	513	514	515	516	517	518	519	519
(4) To abroad	521	522	523	524	525	526	527	528	529	529
Nonconsumption expenditure	591	592	593	594	595	596	597	598	599	599

Note: If the transfer receipts are the major receipts in your household, please give the right code for the Hsien (City) where you have obtained transfer receipts:

5. Consumption Expenditure

Unit : NT$

Item	Serial No.	Amount
1. Food	710	
(1) Main food	711	
(2) Dairy	712	
(4) Fruits	724	
(5) Others	725	
(6) Oils	726	
(7) Board	727	
2. Beverage	730	
(1) Non-alcoholic	731	
(2) Alcoholic	732	
3. Tobacco	740	
4. Clothing and footwear	750	
(1) Clothing	751	
(2) Footwear	752	
5. Rent and water charges	760	
(1) Rent		
a. Actual paid	761	
b. Imputed rent of self-owned	762	
c. Imputed rent of leased and loaned	763	
(2) Repairs	764	
(3) Water charge	765	
(4) Household premiums	766	
6. Fuel and lighting	770	
(1) Electric rate	771	
(2) Gas	776	
(3) Others	777	
7. Furniture and family facilities	780	
(1) Furniture	781	
(2) Textile furnishing	782	
(3) Durable household equipment	783	
(4) Others	784	
8. Household operations	790	
(1) Domestic servants	791	
(2) Service to family	792	
(3) Other household operations	793	
9. Medical care and sanitation	810	
(1) medical equipment and instrument	811	
(2) Treatment in hospital, hospital service, and health insurance	812	
(3) Expenditure of medical article	813	
(4) Personal accident and medical premiums	814	
(5) Medical consumption of NEC	815	
10. Transport and communication	820	
(1) Purchase of personal transport equipment	821	
(2) Expense on operations and maintenance of personal transport equipment	822	
(3) Purchase transportation	823	
(4) Other communications	824	
(5) Motor vehicle premiums	825	
11. Expenditure on recreation, educating and culture	830	
(1) Traveling expenses	831	
(2) Recreation service	832	
(3) Newspaper, magazine and stationery	833	
(4) Recreation facilities	834	
(5) Expenditure on education, cultures and researches	835	
12. Miscellaneous expenditure	840	
(1) Other goods not listed anywhere	841	
(2) Financial service	842	
(3) Personal care	843	
(4) Barber and bath	844	
(5) Food, beverage and tobacco in restaurant, bellevue	845	
(6) Gifts (food excluding)	846	
(7) Miscellaneous expenses	847	
(8) Other non-saving premiums	848	
Total Consumption Expenditure	860	

6. Capital Gain or Loss

Unit : NT$

Item	Serial No.	Amount
1. Capital gain	896	
2. Capital loss	897	

7. Capital Transfers

Unit : NT$

Item	Serial No.	Amount
1. Capital transfers received	898	
2. Capital transfers paid	899	

APPENDIX C: DISTRIBUTION OF POPULATION, 15 YEARS AND OLDER

Table C.1. Distribution of Population (%) Aged 15 Years and Older in Taiwan, 1978-1996

Year	15-24 years	25-49 years	50-64 years	65+ years
1978	31.94	46.12	15.78	6.16
1979	31.14	46.48	16.03	6.35
1980	30.32	46.91	16.26	6.52
1981	29.61	47.29	16.39	6.71
1982	28.97	47.83	16.48	6.72
1983	28.26	48.42	16.52	6.80
1984	27.53	48.90	16.50	7.06
1985	26.80	49.37	16.49	7.34
1986	26.11	49.83	16.45	7.62
1987	25.41	50.33	16.38	7.88
1988	24.54	50.90	16.41	8.15
1989	23.81	51.41	16.38	8.40
1990	23.19	51.91	16.28	8.61
1991	22.81	52.09	16.13	8.96
1992	22.42	52.34	15.99	9.25
1993	22.41	52.19	15.81	9.59
1994	22.20	52.34	15.59	9.87
1995	21.98	52.68	15.19	10.16
1996	21.70	53.05	14.83	10.42

Source: DGBAS, Executive Yuan, Taiwan (1997).

APPENDIX D: WAGE REGRESSIONS FOR 1-10 YEARS AND MORE THAN 10 YEARS OF EXPERIENCE WORKERS

Table D.1 Log Wage Regression for Taiwan,1978-1996(1-10 Years of Experience Workers)

Variable	1978	1981	1984	1987	1990	1993	1996
JuniorHigh	0.224*	0.135*	0.160*	0.088	0.084	0.167	0.181
	(6.12)	(4.13)	(3.63)	(1.89)	(1.12)	(1.14)	(1.18)
SeniorHigh	0.532*	0.431*	0.394*	0.291*	0.266*	0.332*	0.356*
	(15.71)	(13.66)	(9.02)	(6.41)	(3.63)	(2.27)	(2.33)
JuniorCollege	0.779*	0.737*	0.639*	0.495*	0.494*	0.501*	0.528*
	(20.29)	(20.27)	(13.95)	(10.36)	(6.63)	(3.42)	(3.45)
Univ.&above	0.953*	0.981*	0.905*	0.737*	0.747*	0.772*	0.757*
	(24.77)	(26.47)	(19.07)	(14.94)	(9.92)	(5.25)	(4.94)
Experience	0.101*	0.072*	0.060*	0.064*	0.059*	0.060*	0.080*
	(8.00)	(6.43)	(5.21)	(6.14)	(5.93)	(6.21)	(7.99)
Experience^2	-0.00272*	-0.00080	-0.00033	-0.00103	-0.00077	-0.00123	-0.00276*
	(-2.51)	(-0.84)	(-0.338)	(-1.17)	(-0.89)	(-1.48)	(-3.12)
Male	0.142*	0.088*	0.129*	0.140*	0.123*	0.126*	0.109*
	(7.53)	(5.26)	(7.67)	(9.43)	(8.35)	(8.94)	(6.70)
Manufacturing	0.273*	0.378*	0.301*	0.261*	0.255*	0.078	0.299*
	(5.66)	(9.88)	(6.13)	(5.00)	(3.60)	(1.22)	(2.85)
Electricity	0.437*	0.508*	0.251*	0.406*	0.556*	0.116	0.377*
	(5.40)	(7.32)	(2.74)	(4.23)	(4.74)	(1.08)	(2.58)
Construction	0.263*	0.445*	0.337*	0.279*	0.388*	0.196*	0.362*
	(4.50)	(9.65)	(5.93)	(4.60)	(5.18)	(2.94)	(3.39)
Commerce	0.318*	0.427*	0.395*	0.365*	0.331*	0.094	0.344*
	(5.93)	(9.77)	(7.44)	(6.64)	(4.60)	(1.43)	(3.27)
Transportation	0.431*	0.547*	0.368*	0.325*	0.346*	0.203*	0.385*
	(7.46)	(11.25)	(6.29)	(5.21)	(4.43)	(2.82)	(3.50)
F.I.R.E.	0.370*	0.510*	0.468*	0.293*	0.400*	0.156*	0.330*
	(6.10)	(9.69)	(7.86)	(4.81)	(5.35)	(2.33)	(3.10)
SocialService	0.242*	0.394*	0.328*	0.341*	0.353*	0.182*	0.395*
	(4.62)	(9.25)	(6.28)	(6.23)	(4.90)	(2.79)	(3.75)
R^2	0.43	0.46	0.37	0.37	0.36	0.34	0.30
N	2,578	3,110	3,062	2,904	2,929	2,815	2,394

Note: T-Statistics in parentheses.

* Significant at 5 percent level.

Table D.2 Log Wage Regression for Taiwan,1978-1996 (10+ Years of Experience Workers)

Variable	1978	1981	1984	1987	1990	1993	1996
JuniorHigh	0.158*	0.140*	0.109*	0.121*	0.128*	0.095*	0.133*
	(10.93)	(9.80)	(8.40)	(9.87)	(9.97)	(7.35)	(9.08)
SeniorHigh	0.346*	0.341*	0.357*	0.345*	0.354*	0.262*	0.323*
	(26.07)	(25.67)	(29.08)	(28.62)	(27.97)	(20.97)	(22.46)
JuniorCollege	0.506*	0.551*	0.609*	0.582*	0.560*	0.521*	0.556*
	(25.16)	(28.93)	(35.52)	(35.97)	(33.95)	(33.08)	(31.55)
Univ.&above	0.619*	0.691*	0.737*	0.759*	0.748*	0.730*	0.801*
	(32.64)	(36.32)	(41.78)	(43.26)	(42.66)	(43.69)	(43.92)
Experience	0.034*	0.037*	0.040*	0.045*	0.044*	0.042*	0.037*
	(14.34)	(16.50)	(5.21)	(22.48)	(5.93)	(21.39)	(17.24)
$Experience^2$	-0.00056*	-0.00061*	-0.00066*	-0.00074*	-0.00070*	-0.00066*	-0.00055*
	(-13.01)	(-15.10)	(-17.92)	(-21.44)	(-19.88)	(-19.60)	(-14.37)
Male	0.501*	0.491*	0.442*	0.408*	0.378*	0.333*	0.291*
	(43.53)	(49.13)	(46.33)	(45.29)	(41.66)	(39.23)	(31.06)
Manufacturing	0.367*	0.420*	0.278*	0.274*	0.318*	0.268*	0.193*
	(23.09)	(28.27)	(17.26)	(16.91)	(17.69)	(13.44)	(7.28)
Electricity	0.548*	0.636*	0.435*	0.453*	0.550*	0.469*	0.426*
	(14.33)	(16.23)	(12.53)	(12.34)	(15.14)	(11.55)	(9.69)
Construction	0.401*	0.457*	0.331*	0.339*	0.463*	0.450*	0.293*
	(20.76)	(25.19)	(17.97)	(18.64)	(23.43)	(21.55)	(10.55)
Commerce	0.505*	0.547*	0.466*	0.395*	0.427*	0.333*	0.252*
	(21.66)	(25.44)	(22.01)	(18.80)	(19.81)	(14.75)	(8.84)
Transportation	0.555*	0.583*	0.458*	0.428*	0.480*	0.439*	0.366*
	(27.78)	(29.39)	(21.74)	(20.31)	(21.23)	(18.14)	(12.08)
F.I.R.E.	0.633*	0.637*	0.540*	0.485*	0.515*	0.463*	0.382*
	(19.54)	(21.05)	(19.17)	(17.20)	(19.79)	(17.99)	(12.16)
SocialService	0.329*	0.389*	0.308*	0.347*	0.382*	0.363*	0.264*
	(18.46)	(22.63)	(17.03)	(19.28)	(19.39)	(17.26)	(9.61)
R^2	0.43	0.45	0.44	0.44	0.41	0.38	0.38
N	9,286	10,184	10,796	10,939	10,865	11,408	9,088

Note: T-Statistics in parentheses.

* Significant at 5 percent level.

APPENDIX E: DESCRIPTION AND MATCH OF TRADE DATA AND EMPLOYMENT DATA

The trade data published by Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan, Taiwan includes the export values of agricultural, fishery, and forestry finished goods, and manufacturing finished goods, and import values of agricultural and manufacturing materials, capital equipment and consumption goods starting from 1981.

The employment data also published by DGBAS has the individual working industries, including agriculture, fishery and forestry, mining, manufacturing, electricity, gas and water, construction, commerce, transportation, storage and communication, finance, insurance and real estate, business and industrial services, social, personal and related community services, and public administration.

In order to match the trade and employment data, we aggregate these two data sets as the way shown in Table E.1.

Since the industries in "Non-traded goods and services" sector, by definition, don't have any export and import, the I_k's would be zero in my calculation. When we calculate the trade effect on this sector, we only consider the "scale effect", $\frac{\Delta I}{Y}$, because $\frac{dI_k}{Y_k}$ is zero here. ΔI is the change in aggregate trade deficit. If aggregate trade deficit increases over a period ($\Delta I > 0$), the trade effect will predict increase in employment demand in the non-traded sector only based on scale effect.

Table E.1 Match of Trade Data and Employment Data

Sector	Trade data	Employment data
Traded Goods	Agricultural, Fishery, Forestry finished goods and materials, Manufacturing finished goods and materials	Agriculture, Fishery, Forestry, Mining, and Manufacturing
Traded Services	Consumption goods	Commerce, Finance, Insurance, Real Estate, and Business and Industrial Services
Non-traded Goods and Services		Electricity, Gas and Water, Construction, Transportation, Storage and Communication, Social, Personal and Related Community Services, Public Administration

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