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Education and Taiwan's Changing Employment and Earnings Structure

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Abstract

[Excerpt] Between 1980 and 1992, the enormous changes in economic development in Taiwan had significant impacts on the island's labour market. Examples of these changes include the island's almost legendary and meteoric economic growth, the maintenance of essentially full employment, an increase of around 116 per cent in real labour earnings, considerable upgrading of the educational qualifications of the labour force as a whole, a sustained and systematic shift in the composition of the labour force from agriculture into manufacturing and services and occupational upgrading (defined as the expansion of the share of the labour force in the better occupations, at the expense of the lesser occupations).

The main purpose of this chapter is to provide in-depth analysis of these and other underlying changes in the Taiwanese labour market, with the main focal point being, on the one hand, the linkages between the employment and earnings structures, whilst on the other, the changes in the education and qualification levels and the new occupational structure of the island's labour force. Our econometric analysis is based upon a dataset taken from the Manpower Utilization Surveys (MUS) produced by the Directorate-General of Budget, Accounting and Statistics (DGBAS) in Taiwan, covering the years 1980 to 1992. The data for 1993 is not used in this chapter, despite being available to us, essentially because the occupation codes adopted after 1992 were incompatible with those of the earlier years.

Keywords

Taiwan, employment, earnings, development, economic growth, labor market

Disciplines

Education | Income Distribution | International and Comparative Labor Relations | Labor Economics | Labor Relations | Regional Economics

Comments

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Gary S. Fields and Amanda Newton Kraus

INTRODUCTION

Between 1980 and 1992, the enormous changes in economic development in Taiwan had significant impacts on the island's labour market. Examples of these changes include the island's almost legendary and meteoric economic growth, the maintenance of essentially full employment, an increase of around 116 per cent in real labour earnings, considerable upgrading of the educational qualifications of the labour force as a whole, a sustained and systematic shift in the composition of the labour force from agriculture into manufacturing and services and occupational upgrading (defined as the expansion of the share of the labour force in the better occupations, at the expense of the lesser occupations).[1]

The main purpose of this chapter is to provide in-depth analysis of these and other underlying changes in the Taiwanese labour market, with the main focal point being, on the one hand, the linkages between the employment and earnings structures, whilst on the other, the changes in the education and qualification levels and the new occupational structure of the island's labour force. Our econometric analysis is based upon a dataset taken from the Manpower Utilization Surveys (MUS) produced by the Directorate-General of Budget, Accounting and Statistics (DGBAS) in Taiwan, covering the years 1980 to 1992. The data for 1993 is not used in this chapter, despite being available to us, essentially because the occupation codes adopted after 1992 were incompatible with those of the earlier years.

The MUS sub-sample used here includes all full-time and part-time workers employed in paid jobs during the week of the manpower survey, as well as other workers also employed in paid jobs who were not working during that week either as a result of illness or absence on holiday. Based upon these criteria, the overall sample includes workers who were either self-employed or who were themselves employers, but does not include unpaid family workers.

The MUS designates individual workers under one of eight educational levels: (i) illiterate; (ii) self-educated; (iii) primary school; (iv) junior high school; (v) academic high school; (vi) vocational high school; (vii) junior college; and (viii) university or higher. The survey also designates occupations according to two-digit occupational codes aggregated into seven broad occupational categories: (i) agriculture and related occupations; (ii) production workers, artisans and labourers; (iii) service workers; (iv) clerical workers; (v) sales staff; (vi) professional and technical staff; and (vii) administrative and managerial staff.

For the purposes of analysis in this chapter, the data is aggregated into three educational levels and three occupational groups, since such aggregation makes it easier to determine any underlying patterns within the data. The three educational levels used here are: (i) primary education, comprising of the illiterate, the self-educated and those with primary school education or below; (ii) secondary education, comprising of those educated to junior high, academic high or vocational high school level; and (iii) higher education, comprising of those educated to junior college level or above.

The three aggregated occupational groups used in this chapter are: (i) unskilled occupations, including agriculture and related occupations, plus production workers, artisans and labourers; (ii) semi-skilled occupations, including service, clerical and sales occupations; and (iii) skilled occupations, including professional, technical, administrative and managerial occupations.

The Employment Structure in Taiwan

Our analysis begins with an examination of the structure of employment and the ways in which this changed over the 1980-1992 period. As Table 3.1 shows, there was an increase in the share of the labour force with both higher and secondary education, alongside a corresponding reduction in the share of workers with only primary education. Table 3.2, which presents details on the share of employment, by occupation, also indicates a substantial increase in the proportion of workers employed in semi-skilled and skilled jobs over the same period, alongside a corresponding decline in the proportion of workers in unskilled jobs.

As the figures in Tables 3.1 and 3.2 indicate, there were significant improvements in the educational and occupational attainments for both men and women throughout the period under examination. Tables 3.3 and 3.4 go on to provide details of the changes in the employment structure, by both educational level and occupation. Evidence of falling occupational attainments for those with higher education is provided in Table 3.3, along with evidence of rising occupational attainments for those educated to secondary level.

Table 3.1 Share of employment, by gender and education, 1980 and 1992

Unit: %

Level of Education	1980	1992	% Change
Primary Education			
Male	53.2	32.2	-21.1
Female	47.8	30.6	-17.3
Totals	51.6	31.6	-20.0
Secondary Education			
Male	36.5	50.9	14.4
Female	42.6	51.0	8.5
Totals	38.3	51.0	12.7
Higher Education			
Male	10.3	16.9	6.7
Female	9.6	18.4	8.8
Totals	10.1	17.4	7.3

Table 3.2 Share of employment, by occupation, 1980 and 1992

Unit: %

Occupation	1980	1992	% Change
Unskilled			
Male	64.6	56.5	-8.1
Female	56.7	36.8	-19.9
Totals	62.2	49.9	-12.3
Semi-skilled			
Male	17.9	20.1	2.2
Female	31.8	43.2	11.4
Totals	22.1	27.9	5.8
Skilled			
Male	17.5	23.3	5.8
Female	11.5	20.0	8.5
Totals	15.7	22.2	6.5

If we divide the whole period into two sub-periods and then undertake a comparison, we can soon determine the causes of the observed changes in occupational attainment; thus, in addition to data on 1980 and 1992, Tables 3.3 and 3.4 also include data on 1986. When we compare the 1980 and 1986 data we can see that from their position in 1980, workers educated to secondary and higher levels achieved lower occupational categories in 1986; however, the same groups of workers succeeded in moving into the higher occupational categories between 1986 and 1992. Such differences in occupational attainment during the two sub-periods can be attributed to the rapid increase in the pace of occupational upgrading during the latter half of the 1980s and the early 1990s.

*Table 3.3 Occupational attainment, 1980-1992**

Occupational Level	Occupational Attainment			% Change		
	1980	1986	1992	1980-1986	1986-1992	1980-1992
Unskilled						
Primary education	77.7	74.3	73.2	-1.5	-2.1	-3.5
Secondary education	55.2	56.3	49.6	1.2	-4.1	-2.9
Higher education	9.5	9.2	8.4	-0.9	-0.8	-1.7
Semi-skilled						
Primary education	14.7	15.7	16.2	0.5	2.3	2.7
Secondary education	30.1	29.5	33.1	-1.0	1.4	0.4
Higher education	29.8	33.2	34.0	2.5	-0.4	2.2
Skilled						
Primary education	7.6	10.0	10.6	1.0	-0.2	0.8
Secondary education	14.7	14.2	17.3	-0.2	2.7	2.5
Higher education	60.7	57.6	57.6	-1.7	1.2	-0.5

Note: * Occupational attainment = percentage of workers in each educational level employed within each occupational group.

*Table 3.4 Education and employment mix, by occupation, 1980-1992**

Occupational Level	Education/Employment Mix			% Change		
	1980	1986	1992	1980-1986	1986-1992	1980-1992
Unskilled						
Primary education	64.5	54.1	46.4	-10.4	-7.7	-18.0
Secondary education	34.0	43.9	50.6	9.9	6.7	16.6
Higher education	1.5	2.0	3.0	0.4	1.0	1.4
Semi-skilled						
Primary education	34.3	27.5	18.4	-6.8	-9.1	-15.9
Secondary education	52.2	55.4	60.4	3.2	5.0	8.2
Higher education	13.5	17.1	21.2	3.6	4.1	7.7
Skilled						
Primary education	25.1	23.7	15.1	-1.4	-8.6	-10.0
Secondary education	36.0	36.1	39.8	0.1	3.7	3.8
Higher education	38.9	40.2	45.1	1.3	4.9	6.2

Note: * Education and employment mix, by occupation = the employment share of each educational level within each occupation group.

The rate of reduction in the share of unskilled jobs to total employment during the second period was twice that of the first period, along with corresponding increases in the share of semi-skilled jobs to total employment (1.8 times faster than in the first period) and the share of skilled jobs (2.1 times faster). Thus, workers with secondary and higher education were able to attain higher occupational levels in the second period, despite the substantial overall increase in the supply of these higher-educated workers within the labour market.

The Earnings Structure in Taiwan

This section presents data on Taiwan's earnings structure, with the simple tabulations of the earnings data for 1980 and 1992 indicating clear patterns for both years (Table 3.5).[2]

Table 3.5 Earnings structure in Taiwan, 1980 and 1992 *

Categories of Workers	1980 (NT$)	1992 (NT$)	% Change
Educational Category			
Primary education	10,350	20,695	100.0
Secondary education	11,140	23,758	113.0
Higher education	16,947	33,128	96.0
Occupational Level			
Unskilled	9,467	20,833	120.0
Semi-skilled	10,901	21,817	100.0
Skilled	19,226	35,758	86.0
Gender			
Male	12,745	27,553	116.0
Female	7,975	18,268	129.0
Experience			
0-8 years	8,842	19,596	122.0
9-16 years	12,534	25,996	107.0
≥17 years	12,204	25,611	110.0
All Employed Persons	11,315	24,421	116.0

Note: * Earnings are quoted in 1991 New Taiwan dollars (NT$).

First of all, we find from Table 3.5 that with a rise in education there was a corresponding rise in earnings, with the secondary to primary earnings ratio standing at 1.1 to 1 in 1980 and 1.2 to 1 in 1992, whilst the higher to secondary ratio was 1.5 to 1 in 1980 and 1.4 to 1 in 1992.

Secondly, workers in skilled occupations earned more than workers in semi-skilled occupations, who in turn earned more than workers in unskilled occupations. Thirdly, men earned substantially more than women, with the male/female earnings ratio standing at 1.6 to 1 in 1980 and 1.5 to 1 in 1992. Finally, the effect of experience on earnings was a rise, followed by a fall, with average earnings being highest for those workers with between 9 and 16 years experience.

We now go on to describe the major changes which took place between 1980 and 1992, beginning with the rise in real earnings for every group of workers in Taiwan. The overall rise in real earnings was 116 per cent, with the highest rises being found amongst women, as well as those workers with the lowest experience, those in the middle education category and those in the lowest occupational category. When breaking down the data, we first consider the fact that the greatest increase in earnings was found amongst workers with secondary education; thereafter, when the data is disaggregated into the eight original educational groups, we can see that the largest increase in earnings was, by far, amongst the group of workers educated to junior high school level, at 125 per cent. The next largest increase, at 108 per cent, was experienced amongst the professional high school group.

If we then go on to add in even more detail, we find that for all workers educated to junior high school level, those in the unskilled occupations enjoyed the greatest increases in earnings, with the rate of increase for this particular education/occupation group being 142 per cent, significantly higher than the overall average increase of 116 per cent. One possible explanation for such disparity in the rise in earnings is that the significant reduction in the supply of workers educated to primary school level may have led to an overall increase in the relative wage of these workers, particularly those in unskilled occupations, where this group was mainly employed.

This increase in the unskilled primary wage may then have led to an increase in demand for the group of workers which could be considered the closest and cheapest substitute, workers with the next highest education level, that is, workers with junior high school education. Such an increase in demand would of course lead to an increase in the relative wages of the unskilled junior high school group. At the same time, workers educated to junior high school level shifted to semi-skilled and skilled jobs, resulting in a reduction in the supply of these workers available to fill unskilled jobs, which thereby led to a further increase in the relative wages of the unskilled junior high school group. These two effects, combined with the rising demand coming as a result of economic growth, may have been sufficient to cause the extraordinary growth in overall earnings for workers educated to junior high school and secondary high school levels.

Next, we consider the fact that earnings increased most in unskilled occupations, which, at first glance, was probably the straightforward result of a significant reduction in the supply of uneducated, cheap labour into the unskilled occupational sectors. As shown in Table 3.3, in 1980, 65 per cent of workers in unskilled occupations were educated to primary level or below; however, by 1992, educational expansion had reduced this share to 46 per cent, indicating that employers who had unskilled jobs which they needed to fill were finding that they needed to hire better-educated and more expensive workers. In specific terms, in 1992, the average earnings of those working in unskilled occupations and educated to secondary level were 13 per cent higher than those with primary level education, whilst the average earnings of those with higher education were 35 per cent higher.

A more detailed look at additional data supports this finding, showing that there was an increase of eight years in the average age of workers in unskilled occupations between 1980 and 1992. By contrast, the average age of workers in semi-skilled occupations increased by only five years, whilst the average age of workers in skilled occupations increased by less than one year. These figures suggest that earnings in unskilled jobs may also have been rising relative to those in the other occupation groups, because unskilled workers were climbing much more quickly up their age/earnings profiles. However, when the earnings data for each occupation is disaggregated by age cohort, we find that earnings in unskilled occupations increased more rapidly for every cohort. This result indicates that the decrease in the supply of workers to fill unskilled occupations, regardless of age, was the main driving force behind the change in the occupational earnings structure. In the next section, we go on to explore the effects on the changing educational earnings structure stemming from the interaction between educational expansion and the changes in occupational attainment.

THE DETERMINATION OF EARNINGS, BY OCCUPATION AND EDUCATIONAL LEVEL

The hypothetical relationships that exist between education, earnings and occupation are illustrated in Figure 3.1, where the arrow marked '1' indicates that education has a direct effect on earnings; that is, in any given occupation, workers with better education are expected to have higher earnings, on average, than workers with lower education. This result may be due to the human capital effects of education, to a correlation between education level and innate ability or to a mixture of both. The arrow marked '2' indicates that there is also some likelihood of the existence of a direct relationship between occupation and earnings which is independent of education; indeed,

some occupations pay better than others, regardless of the education level of the employee, and there are in fact many reasons why wages might vary according to occupation.

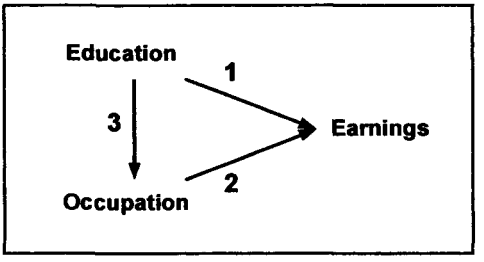

Figure 3.1 The hypothetical relationships between education, occupation and earnings

On the one hand, different occupations are likely to employ different types of workers; indeed, it is much more likely that a higher proportion of highly productive and capable workers will be employed in higher-skilled jobs than in lower-skilled jobs. Thus, it is also expected that the higher-skilled jobs will pay more, on average, than the lower-skilled jobs.[3] On the other hand, it may well be that there is some association between occupational wage differentials and actual job characteristics, such as compensatory differentials and the practice of offsetting training costs, or with labour market institutions such as unions or labour legislation which have greater coverage of certain occupations than others. It is only in the case of offsetting training costs that higher occupational wages will necessarily have any association with greater skills.

The arrow marked '3' indicates that education affects earnings by altering the probability that a given worker will be employed in a given occupation; that is, that there is a greater likelihood of a higher-educated worker having a highly skilled job. This expectation is based upon two factors, each of which may hold simultaneously. The first is that education imparts skills which increase the likelihood of the educated worker being more productive in a highly skilled job, and thus more competitive in the market for such jobs. The second is that education acts as a signal to employers helping them to identify the most capable workers.

Taken together, these three hypothetical relationships constitute an implicit fourth hypothesis. In addition to its direct effect on earnings, education as a determinant of occupation also has an indirect effect, with the acquisition of education being a means of securing the higher wages associated with more highly skilled jobs.

Analysis of the Effects of Education and Occupation on Earnings

Reduced form and structural estimates[4]

The direct effects of education and occupation are estimated here using an earnings function within which education (ed) and occupation (occ) are explicitly entered as explanatory variables:

$$\ln E = h(ed, occ, X), \tag{1}$$

where lnE is the natural log of real earnings and X is a vector of personal characteristics. The direct effects of education and occupation (DIR_e and DIR_o) are simply the estimated coefficients on the education and occupation variables in Equation (1), with these variables being respectively formulated as dummy variables representing secondary and higher education, as well as semi-skilled and skilled occupations.

Thus, the direct effects of education and occupation are measured in terms of the amounts by which higher education and employment in a more skilled job increase the earnings of a worker, relative to the appropriate base categories of primary education and unskilled occupations. The indirect effect of having received higher education is defined as the amount by which the likelihood of workers gaining employment in higher-skilled jobs will effectively raise the expected earnings of those workers with higher education, relative to the expected earnings of those with lower education, thus reflecting the relationships represented by the arrows marked '2' and '3' in Figure 3.1.

To be more specific, the indirect effect of education level e is defined here as: (i) the weighted sum of the direct effects of all occupations on earnings, where these weights are equal to the probability levels of being employed in these occupations conditional on achieving education level e; minus (ii) the weighted sum of the direct effects of all occupations on earnings, where these weights are equal to the probability levels of being employed in these occupations conditional on having some base education level. The indirect effect of education level e is therefore defined in algebraic terms, as:

$$IND_e = \sum_o DIR_o P_{o|e} - \sum_o DIR_o P_{o|b}, \tag{2}$$

where IND_e is the indirect effect of education level e, DIR_o is the direct effect of occupation o, $P_{o|e}$ is the probability of employment in occupation o conditional on having education level e and $P_{o|b}$ is the probability of being employed in occupation o conditional on having the base education level.

The probabilities of being employed in a given occupation conditional on education level are generated by estimating occupational attainment functions of the form:

$$Occ = g(ed, Z), \tag{3}$$

where Occ is a three-way dependent variable (skilled occupation, semi-skilled occupation or unskilled occupation) and Z is a vector of personal characteristics not necessarily equal to X.

Equations (1) and (3) make up a structural model of earnings determination; when occ is dropped, we have the reduced form earnings function:

$$lnE = h'(ed, X), \tag{4}$$

which, although providing the total effect of education on earnings, does not separate out the direct effects from the indirect effects.

We subsequently undertake estimation of both the reduced form and the structural model in order to compare the direct and indirect effects of education on earnings using the total effect, as estimated by the reduced form model. The arguments of the reduced form earnings function (Equation 4) used to measure the total effects of education are:

$$\begin{aligned} lnE = {} & a + b(exp) + c(exp)2 + d(sex) + e(tenure) + f(tenure)2 \\ & + g(lnhours) + \Sigma_e\, h_i\, (ed_e) + j(employer) + k(self\text{-}employed) + u, \end{aligned} \tag{5}$$

where lnE is the natural log of monthly earnings; sex is a dummy variable with male being equal to 1; tenure is the number of years in the current job; and lnhours is the natural log of hours per week.[5] Since we do not have any actual data on experience or years of schooling, in this analysis, experience (exp) refers to potential experience and is calculated as age, minus six years, minus the estimated years of schooling.[6] The education (ed) variables are entered in three categories, with the omitted variable being primary level education.

The terms 'employer' and 'self-employed' are dummy variables, with the former being equal to 1 if the worker is an employer and the latter being equal to 1 if the worker is self-employed. These variables are included within the equation as a means of separating out the potential returns to capital from the effects of education; such returns may be accrued by those who are self-employed or who own businesses employing others. The estimation results, using the 'ordinary least squares' (OLS) method, are presented in Table 3.6.

Table 3.6 Earnings functions, without occupation variables, 1980-1992 *

Variables	1980		1986		1992	
	Coefficient	S.D.	Coefficient	S.D.	Coefficient	S.D.
Secondary Education	0.2086	0.0078	0.2530	0.0080	0.2145	0.0092
Higher Education	0.6195	0.0113	0.6737	0.0105	0.5729	0.0112
Potential Experience	0.0362	0.0009	0.0331	0.0008	0.0309	0.0009
Potential Experience squared	-0.0006	0.0000	-0.0006	0.0000	-0.0006	0.0000
Sex, male = 1	0.3194	0.0070	0.3397	0.0063	0.3363	0.0067
Tenure	0.0114	0.0011	0.0232	0.0001	0.0252	0.0011
Tenure squared	-0.0004	0.0000	-0.0006	0.0000	-0.0008	0.0000
Log of Hours per Week	0.6252	0.0156	0.6067	0.0120	0.7105	0.0150
Semi-skilled	–	–	–	–	–	–
Skilled	–	–	–	–	–	–
Employer	0.5395	0.0145	0.4638	0.0140	0.3424	0.0138
Self-employed	-0.1489	0.0082	-0.1529	0.0076	-0.1711	0.0084
Constant	5.6554	0.0617	6.1655	0.0474	6.4456	0.0589
No. of Obs.	24,403		27,759		27,740	
Adj. R^2	0.3810		0.4106		0.3683	

Note: * All coefficients are significant at better than the 1 per cent level.

From the reduced form analyses for 1980, 1986 and 1992, we can first of all determine that education raises earnings. Specifically, relative to primary education, the effects of such raised earnings are greater for those with higher education than for those with secondary education. We also find that earnings rise with potential experience at a decreasing rate, peaking at about 28-years experience, and that earnings rise with tenure at a decreasing rate, peaking at about 17-years tenure. Men earn more than women, ceteris paribus, and although employers earn significantly more than wage employees, the self-employed earn significantly less. Finally, as expected, earnings increase with hours worked.

Next, we turn to the estimations of the structural earnings model. The parameters of the equation for this model are obtained in the same way as those for the reduced form model, except that the parameters in the structural earnings model also include occupation dummies. These are included first of all to facilitate the estimation of the effect of occupation on earnings, and secondly, to separate out the effect of occupation from the effect of education:

$$\begin{aligned} \ln E = {} & a' + b'(\exp) + c'(\exp)2 + d'(\text{sex}) + e'(\text{tenure}) \\ & + f'(\text{tenure})2 + g'(\ln\text{hours}) + \Sigma_e\, h'_i(ed_e) + \Sigma o\, i'\, o(\text{occ}) \\ & + j'(\text{employer}) + k'(\text{self-employed}) + u'. \end{aligned} \tag{6}$$

Although the occupation variable is regarded as being endogenous in Equation (6), we have made no attempt at instrumenting this variable. This is essentially because there are no available instruments which have a sufficiently high correlation with occupation; and indeed, it is already well recognized that when there is only a weak correlation between potential instruments and an endogenous variable, the estimation of instrumental variables can produce some serious problems (Bound et al., 1995; Staiger and Stock, 1997). In our view, the prospect of a 'cure' by the use of instrumental variables is worse than the 'disease' of endogeneity bias itself; therefore, the OLS estimation method is used. The estimation results are presented in Table 3.7.

From our standardized earnings function estimates, we find that, in general, all of the previous results provided by the simple earnings functions are confirmed for all three years; however, the inclusion of the occupation dummies substantially reduces the coefficients on all of the education variables. When controlling for occupation, the estimated effects of both secondary and higher education are reduced by about a half for 1980, whilst the education coefficients are reduced by about 40 per cent for 1986 and 1992.

Table 3.7 Earnings functions, with occupation variables, 1980-1992 *

Variables	1980		1986		1992	
	Coefficient	S.D.	Coefficient	S.D.	Coefficient	S.D.
Secondary Education	0.1037	0.0080	0.1583	0.0080	0.1285	0.0092
Higher Education	0.3281	0.0130	0.4050	0.0118	0.3360	0.0125
Potential Experience	0.0310	0.0009	0.0294	0.0008	0.0288	0.0009
Potential Experience squared	-0.0006	0.0000	-0.0006	0.0000	-0.0005	0.0000
Sex, male = 1	0.3526	0.0069	0.3814	0.0062	0.3798	0.0068
Tenure	0.0094	0.0011	0.0208	0.0010	0.0233	0.0011
Tenure squared	-0.0004	0.0000	-0.0005	0.0000	-0.0008	0.0000
Log of Hours per Week	0.5754	0.0151	0.5478	0.0117	0.6594	0.0147
Semi-skilled	0.1757	0.0077	0.1780	0.0070	0.1388	0.0076
Skilled	0.4120	0.0103	0.3822	0.0090	0.3537	0.0092
Employer	0.3552	0.0148	0.2981	0.0142	0.1906	0.0141
Self-employed	-0.1892	0.0080	-0.2091	0.0075	-0.2246	0.0083
Constant	5.8857	0.0599	6.4158	0.0462	6.6450	0.0576
No. of Obs.	24,403		27,759		27,740	
Adj. R^2	0.4215		0.4490		0.4007	

Note: * All coefficients are significant at better than the 1 per cent level.

We find that earnings are higher in the more skilled occupations, ceteris paribus; however, a further striking finding is that despite the enormous educational expansion which took place in Taiwan after 1980, there was no marked reduction in educational wage differentials. This phenomenon appears not only in the estimates reported above, but also in a number of other studies on Taiwan using data from both the Manpower Utilization Surveys and the Survey of Household Income and Expenditure (Fields and O'Hara, 1999; Bourguignon et al., 1999; Sun and Gindling, 2001; Gindling and Sun, 2002).

We now go on to further discuss the ways in which adjustments occurred within the Taiwanese labour market to bring about this particular phenomenon.

Occupational attainment functions

In this sub-section, we turn our attention to the estimation of the occupational attainment functions. These estimates are generated using a multinomial logit model which provides, as a function of various personal characteristics, the probability of being employed in one occupation, relative to the probability of being employed in another.[7]

In the three-outcome case, the multinomial logit model simultaneously estimates two equations of the following form:

$$\ln(P_o/P_b) = a + b(\text{experience}) + c(\text{sex}) + d(\text{age}) + \Sigma_e\, e_e\, (ed_e) \qquad (7)$$

where P_o is the probability of being employed in occupation o and P_b is the probability of being in the base category (the unskilled occupation group), Education level is entered as a set of dummy variables, with primary education establishing the base, Sex is a dummy variable, with male being equal to 1, and the Age variable is entered continuously. The estimation results are provided in Table 3.8.[8]

The models perform reasonably well, with the chi-squared statistic being significant at better than the 1 per cent level, as are all of the estimated coefficients. The positive coefficients on secondary and higher education, which are consistent with our expectations, are interpreted to mean that relative to primary education, secondary and higher education increase the probability of being employed in a semi-skilled or skilled job, rather than in an unskilled job.

Similarly, the positive coefficient on the age variable indicates that being older increases the probability of achieving higher occupational categories as opposed to lower ones. The negative coefficient on the sex variable is, however, unexpected, as it indicates that given both education and age, men are less likely than women to work in semi-skilled or skilled occupations.

We can interpret this particular finding as showing that women are not typically employed in unskilled jobs where there is a requirement for physical strength, as opposed to any indication of discrimination against men in the higher-skilled occupations.

Table 3.8 Multinomial logit models of occupational attainment, 1980-1992[a]

Variables[b]	1980		1986		1992	
	Coefficient	S.D.	Coefficient	S.D.	Coefficient	S.D.
Semi-skilled						
Secondary	1.4700	0.0407	1.3489	0.0407	1.3064	0.0442
Higher	3.1380	0.0816	3.2502	0.0720	3.1181	0.0681
Age	0.0353	0.0015	0.0313	0.0015	0.0095	0.0016
Sex, male = 1	-0.9324	0.0368	-1.0146	0.0331	-1.3150	0.0329
Constant	-2.4763	0.0652	-2.2789	0.0695	-1.1700	0.0789
Skilled						
Secondary	1.8642	0.0533	1.6439	0.0501	1.8178	0.0518
Higher	4.8912	0.0839	4.7536	0.0750	4.7584	0.0717
Age	0.0690	0.0018	0.0694	0.0018	0.0597	0.0018
Sex, male = 1	-0.2341	0.0512	-0.4739	0.0426	-0.6917	0.0399
Constant	-5.1576	0.0913	-4.8788	0.0880	-4.3910	0.0941

Notes:

[a] For the 1980 equations, $\chi^2(8) = 7646.77$, pseudo $R^2 = 0.1687$ and N = 24,655; for the 1986 equations, $\chi^2(8) = 8439.33$, pseudo $R^2 = 0.1551$ and N = 28,167; and for the 1992 equations, $\chi^2(8) = 9846.39$, pseudo $R^2 = 0.1694$ and N = 28,019.

[b] All variables are significant at better than the 1 per cent level.

The occupational attainment functions are used to estimate the conditional probabilities of employment in each of the three occupation groups, for each education level, whilst holding both age and sex constant. Details on the estimated probabilities are presented in Panel A of Table 3.9, whilst Panel B of Table 3.9 provides the actual occupation attainment, as reported in Table 3.3.[9] The predicted and actual occupational attainment data demonstrate the same general pattern; in all three years, the employment of workers with primary education is concentrated in unskilled jobs, the employment of workers with secondary education is concentrated in unskilled and semi-skilled jobs, and the employment of workers with higher education is concentrated in skilled jobs. Standardizing for the effects of age and gender changes the average occupational attainment only slightly for all three education groups.

Table 3.9 Predicted and actual occupational attainment, 1980-1992

Unit: %

Variables [a]	1980	1986	1992
Panel A: Predicted Occupational Attainment			
Primary Education			
Unskilled	80.7	79.2	77.1
Semi-skilled	13.2	13.7	16.0
Skilled	6.1	7.1	6.9
Secondary Education			
Unskilled	48.8	50.0	45.9
Semi-skilled	31.5	30.5	31.9
Skilled	19.7	19.5	22.2
Higher Education			
Unskilled	9.8	8.9	8.1
Semi-skilled	29.7	32.3	31.9
Skilled	60.5	58.8	60.0
Panel B: Actual Occupational Attainment [b]			
Primary Education			
Unskilled	77.7	74.3	73.2
Semi-skilled	14.7	15.7	16.2
Skilled	7.6	10.0	10.6
Secondary Education			
Unskilled	55.2	56.3	49.6
Semi-skilled	30.1	29.5	33.1
Skilled	14.7	14.2	17.3
Higher Education			
Unskilled	9.5	9.2	8.4
Semi-skilled	29.8	33.2	34.0
Skilled	60.7	57.6	57.6

Notes:

[a] Predicted occupational attainment = the level of attainment predicted by the occupational attainment functions minus the predicted probability of being employed in occupation o, conditional on having education level e, whilst holding age and sex constant.

[b] Actual occupational attainment = the percentage of workers within each education level employed in each occupation group.

THE DIRECT, INDIRECT AND TOTAL EFFECTS OF EDUCATION ON EARNINGS

We now have all the information required to calculate the direct, indirect and total effects of education on earnings. The direct effects are obtained from the estimates of Equation (6), presented earlier in Table 3.7, and are reported in the first rows of Table 3.10.

Table 3.10 The effects of education on earnings, 1980-1992

Unit: %

Educational Effects	Increase in Earnings *		
	1980	1986	1992
Direct Effect			
Secondary Education	10.4	15.8	12.8
Higher Education	32.8	40.5	33.6
Indirect Effect			
Secondary Education	8.8	7.7	7.6
Higher Education	25.3	23.1	21.0
Sum of Direct plus Indirect Effects			
Secondary Education	19.2	23.6	20.5
Higher Education	58.1	63.6	54.6
Total Effects			
Secondary Education	20.9	25.3	21.5
Higher Education	62.0	67.4	57.3

Note: * This uses the standard linear approximation of the effect on the natural log of earnings to the percentage changes in earnings, relative to primary education.

We can see from Table 3.10 that relative to primary education and depending on the year, secondary education raises earnings by 10 to 13 per cent, whilst higher education raises earnings by 33 to 41 per cent. The estimates of the direct effects of occupation can then be combined with the estimates of conditional occupational attainment (Equation (7) and Table 3.8) to calculate the indirect effects of education on earnings according to Equation (2).

For example, the indirect effect of higher education is given by:

$$IND_{higher} = \sum_o \hat{d}_o \hat{P}_{o \mid higher} - \sum_o \hat{d}_o \hat{P}_{o \mid primary} \qquad (8)$$

where $\hat{d}_o$ is the estimated coefficient on occupation o from Equation (6); $\hat{P}_{o|\text{higher}}$ is the estimated probability of being employed in occupation o conditional on having higher education; and $\hat{P}_{o|\text{primary}}$ is the estimated probability of being employed in occupation o conditional on having primary education (i.e., the base-level education). As regards the indirect effects, which are reported in the second group of rows of Table 3.10, all of these are sizeable and in some cases are almost as large as the direct effects. Thus, in Taiwan, a substantial proportion of the returns to education occurs through improved occupational attainment.

The total effect of education on earnings comprises of the effect of the increase in education, in terms of raising earnings within occupations and the improved occupational position of workers. An estimate of this total effect is obtained by means of the reduced form regression (Equation (5) and Table 3.6). In all three years, and for both educational levels, the total effects are quite close to the sum of the direct and indirect effects, which indicates that although there is potential bias in the OLS estimates of the coefficients in the earnings functions (with occupation variables), in practice, the magnitude of this problem actually proves to be quite small.

Analysis of the Effects of Education on Changes in Earnings

The causes of the fairly constant relative wage differentials in Taiwan can be analysed by examining changes over time in the direct, indirect and total effects of education on earnings. These changes are reported in Table 3.11 for two sub-periods, 1980 to 1986 (period 1) and 1986 to 1992 (period 2), as well as for the entire period under examination.

Table 3.11 Changes in the effects of education on earnings, 1980-1992

Unit: %

Educational Effects	% Change		
	1980-1986	1986-1992	1980-1992
Direct Effect			
Secondary Education	5.5	-3.0	2.5
Higher Education	7.7	-6.9	0.8
Indirect Effect			
Secondary Education	-1.1	-0.1	-1.2
Higher Education	-2.3	-2.1	-4.3
Total Effects			
Secondary Education	4.4	-3.8	0.6
Higher Education	5.4	-10.1	-4.7

The changes in the direct and indirect effects in the first period, for both secondary and higher education, generally worked in offsetting directions. For secondary education, although the direct effect increased by 5.5 per cent, the reduction in the indirect effect resulted in the change in the total effect amounting to an increase of only 4.4 per cent. Similarly, for higher education, an increase of 7.7 per cent for the direct effect was reduced to a 5.4 per cent increase in the total effect as a result of the 2.3 per cent negative indirect effect. It should be noted that changes in the direct and total effects were positive for both education levels, despite the substantial increases in the supply of workers with these educational attainments. For both secondary and higher education, all changes in the direct and indirect effects in the second period were negative, as were the total effects. Once again, however, it should be noted that the changes in the direct effects were greater than the changes in the indirect effects for both education levels. For secondary education, there was a 3 per cent reduction in the direct effect, as compared to a mere 0.1 per cent reduction in the indirect effect. For higher education the substantial 6.9 per cent reduction in the direct effect was accompanied by a much smaller reduction, of only 2.1 per cent, in the indirect effect.

For the entire period under examination (1980 to 1992), there was an overall increase in the direct effects of both secondary and higher education on earnings, largely as a result of the substantial increases in the direct effects in the first period. In contrast, reductions in the indirect effects, in both the first and second periods, led to an overall reduction in the indirect effects. For secondary education, the increase in the direct effect over the whole period was large enough to offset the reduction in the indirect effect, resulting in an overall 0.6 per cent increase in the total effect. For higher education, the magnitude of the increase in the direct effect was not sufficient to offset the decrease in the indirect effect, such that there was an overall reduction of 4.7 per cent in the total effect. Thus, relative to primary education, secondary education had a greater effect in 1992 than in 1980, in terms of increasing earnings, whilst in contrast, again relative to primary education, higher education had a greater effect in terms of increasing earnings in 1980 than in 1992.

In order to further analyse the reasons behind the changes in the indirect effect of education on earnings, we disaggregate the indirect effect into changes in occupational attainment conditional on education (i.e., changes in the conditional probabilities) and changes in the direct effect of education on earnings (i.e., changes in the coefficients). Simulated indirect effects of each educational level are calculated by applying the end-of-period probabilities to the initial-period coefficients, so as to isolate the effects of the changes in occupational attainment from those of the changes in the occupational earnings structure. The results are presented in the left-hand side of Tables 3.12 and 3.13. Thereafter, the actual indirect effects at the beginning of the period are

subtracted from the simulated indirect effects at the end of the period in order to generate the simulated changes in the indirect effects. These results are presented in the right-hand side of Tables 3.12 and 3.13.

For the first period, the simulated effect of the changes in occupational attainment on the indirect effect of higher education is calculated in accordance with the following formula:

$$\Delta IND^{P}_{higher} = \left(\sum_{o} \hat{d}^{80}_{o} \hat{P}^{86}_{o|higher} - \sum_{o} \hat{d}^{80}_{o} \hat{P}^{86}_{o|primary}\right) - \left(\sum_{o} \hat{d}^{80}_{o} \hat{P}^{80}_{o|higher} - \sum_{o} \hat{d}^{80}_{o} \hat{P}^{80}_{o|primary}\right) \quad (9)$$

where ΔIND^{P}_{higher} is the simulated change in the indirect effect of higher education on earnings, and the P superscript indicates that this simulation is based upon changes in the conditional probabilities of employment, whilst holding constant the effect of occupation-specific earnings. Similarly, the effects of changes in the occupational earnings structure are also isolated from the effects of the changes in occupational attainment by calculating the simulated changes in the indirect effect in accordance with the following equation:

$$\Delta IND^{C}_{higher} = \left(\sum_{o} \hat{d}^{86}_{o} \hat{P}^{80}_{o|higher} - \sum_{o} \hat{d}^{86}_{o} \hat{P}^{80}_{o|primary}\right) - \left(\sum_{o} \hat{d}^{80}_{o} \hat{P}^{80}_{o|higher} - \sum_{o} \hat{d}^{80}_{o} \hat{P}^{80}_{o|primary}\right) \quad (10)$$

The C superscript in Equation (10) indicates that this simulation is based upon changes in the occupation coefficients from the earnings functions, whilst holding constant the effect of occupational attainment. Table 3.12 presents the results produced by isolating the effects of the changes in occupational attainment, whilst the results produced by isolating the effects of the changes in the occupational earnings structure are presented in Table 3.13.

Table 3.12 The indirect effects of simulated changes in occupational attainment, 1980-1992

Unit: %

Educational Level	Simulated Indirect Effects		Simulated Change ΔIND^{C}_{e}	
	1986	1992	1980 to 86	1986 to 92
Secondary Education	8.1	8.7	-0.7	1.0
Higher Education	24.6	23.2	-0.7	0.1

Table 3.13 The indirect effects of simulated changes in the occupational earnings structure, 1980-1992

Unit: %

Educational Level	Simulated Indirect Effects		Simulated Change ΔIND^{C}_{e}	
	1986	1992	1980-86	1986-92
Secondary Education	8.4	6.7	-0.4	-1.0
Higher Education	23.7	20.9	-1.6	-2.2

In conjunction with the changes in the direct effect of occupation on earnings, the changes in occupational attainment in the first period contributed to the overall reduction in the indirect effects of both secondary and higher education. This is reflected in the negative values for ΔIND^{P}_{higher} and $\Delta IND^{P}_{secondary}$. These negative contributions reflect the fact that between 1980 and 1986 there were net shifts of workers with secondary and higher education out of the higher-skilled and higher-paying occupations into the lower-skilled and lower-paying occupations. Similarly, the negative values for ΔIND^{C}_{higher} and $\Delta IND^{C}_{secondary}$ reflect the fact that the direct effect on earnings from being employed fell by about 7 per cent over the same period. It should be noted that the reduction in ΔIND^{C}_{higher} is greater than the reduction in $\Delta IND^{C}_{secondary}$, which means that the impact of the reduction in the skilled wage premium was greater on the indirect effect of higher education than on the indirect effect of secondary education, because workers with higher education tend to be concentrated more in the higher-skilled jobs.

In the second period, however, changes in the direct effect of occupation on earnings (the coefficient effect 'c') worked in the opposite direction from changes in occupational attainment (the probabilities of employment 'p'). During this period, the direct effect of being employed in a semi-skilled job fell by 22 per cent, whilst the direct effect of being employed in a skilled job fell by 7 per cent. Thus, ΔIND^{C}_{higher} and $\Delta IND^{C}_{secondary}$ were both negative for this period; however, the impacts of these reductions were offset by shifts in the employment of workers in both education groups into more skilled jobs; ΔIND^{P}_{higher} and $\Delta IND^{P}_{secondary}$ were both positive for this period.

For secondary education, the offsetting effects of the changes in both occupational attainment and the occupational earnings structure are of the same magnitude; indeed, they almost cancel each other out, resulting in the 0.1 per cent reduction in the indirect effect reported in Table 3.12. For higher education, the increase in ΔIND^{C}_{higher} swamps the decrease in ΔIND^{P}_{higher}, such that there was a substantial reduction over the period in the indirect effect. Thus, as in the first period, the role played by changes in occupational attainment, with regard to the outcomes of higher education, was relatively minor.

EDUCATIONAL EXPANSION AND THE LABOUR MARKET: TOWARDS AN ANALYTICAL FRAMEWORK

In this section, we begin by taking stock of what has been empirically determined so far in this chapter, and find that the two major economy-wide changes that occurred during the period under examination were rapid economic growth and the high rate of educational expansion. The labour market remained tight, thereby allowing essentially full employment to be maintained and causing real labour earnings to more than double in a period of just 12 years. The labour market improvements were broad-based, insofar as large real wage increases were registered for all labour market groups, including men and women, better-educated and lower-educated workers, highly skilled and lower-skilled workers, experienced workers and recent labour force entrants.

Whilst all of this was happening, two major changes occurred in the occupational structure within Taiwan. Firstly, there were rapid improvements in the occupational mix of jobs, which we refer to as 'occupational upgrading', such that a much larger proportion of workers in Taiwan were able to work in skilled occupations than had previously been the case. Secondly, although better-educated, Taiwanese workers faced declining occupational attainments; that is, given their education, they did not enter the best occupations at the same rate as which they had previously entered, but nor did they remain unemployed; instead, they took up employment in semi-skilled jobs. Overall, then, the educational attainments of workers were higher in each occupational category, although a smaller proportion of workers with higher education was able to enter skilled occupations than before.

What these facts suggest is a standard supply and demand framework with a twist, since the standard framework regards the wages of workers with a given educational attainment as being determined by the demand and supply for that type of worker alone. Suppose, for simplicity, that the labour market can be divided into two segments, skilled and unskilled, with separate labour demand and labour supply curves in each. Workers in this simple model are assumed to be of two types, educated and less-educated, with educated workers supplying their labour only to the skilled market and less-educated workers supplying their labour only to the unskilled market.

Let there be a downward-sloping labour demand curve and an upward-sloping labour supply curve in each segment, with the wage in each being determined by the demand and supply in that segment alone. Skilled jobs pay more than unskilled jobs, which means that demand and supply in the skilled market would have to intersect at a higher wage than in the unskilled market. This is shown in Figure 3.2.

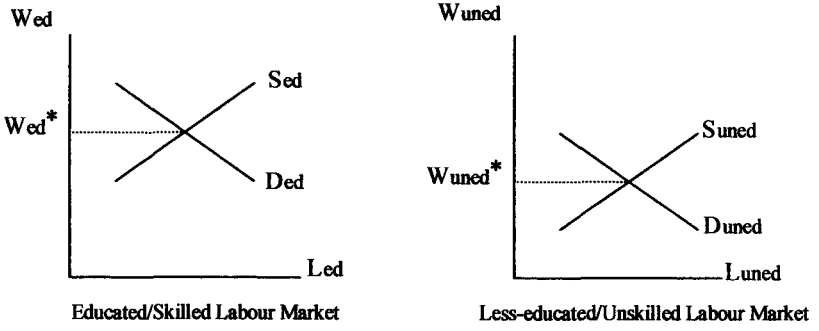

Figure 3.2 Supply and demand in educated and uneducated labour markets

If we now suppose that educational expansion occurs, with this being the only change taking place in the labour market, the labour supply curve of the skilled labour market would shift to the right, whilst the supply curve of unskilled labour would shift to the left. As illustrated in Figure 3.3, the wages for skilled jobs would fall, whilst the wages for unskilled jobs would rise, producing a narrowing of the educated/less-educated wage differential.

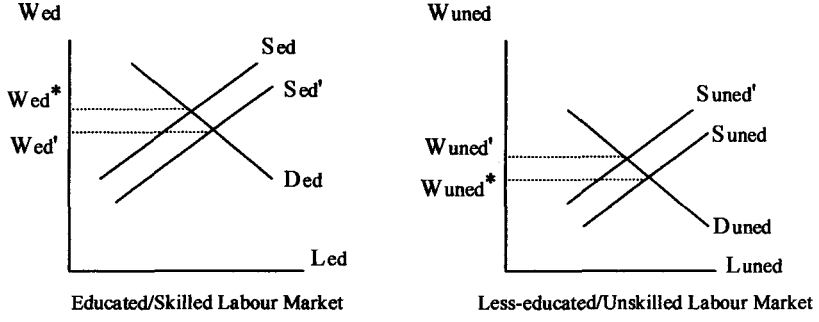

Figure 3.3 Shift in labour supply curves, demand held constant

However, this is not the way that things happened in Taiwan. In the studies mentioned earlier, as well as in our own empirical work, it has been demonstrated that the relative earnings of highly educated workers changed remarkably little, despite the huge increase in their absolute and relative numbers. Furthermore, these same studies have demonstrated that when controls are added, there has in fact been no appreciable fall in the adjusted wage differentials, and indeed, they may even have risen. The theory must therefore be amended to fit these facts. The obvious inference to be drawn from this is that there must also have been a shift in labour demand. If the

demand curve for skilled labour shifts sufficiently rightward, the wages for educated labour will remain constant. Shift the demand curve even more rightward and the wages for educated labour will rise. Similarly, a rightward shift of the demand curve for unskilled labour will generate a larger wage increase for less-educated labour than that which is brought about by a leftward shift in the labour supply curve alone.

Figure 3.4 illustrates the way in which these shifts, taken together, could produce identical percentage wage increases in both the skilled and unskilled markets, thereby leaving the educated/less-educated wage differential essentially constant. It should be noted that the shift in the demand curve for educated labour must be greater than that for less-educated labour in order to obtain this result.

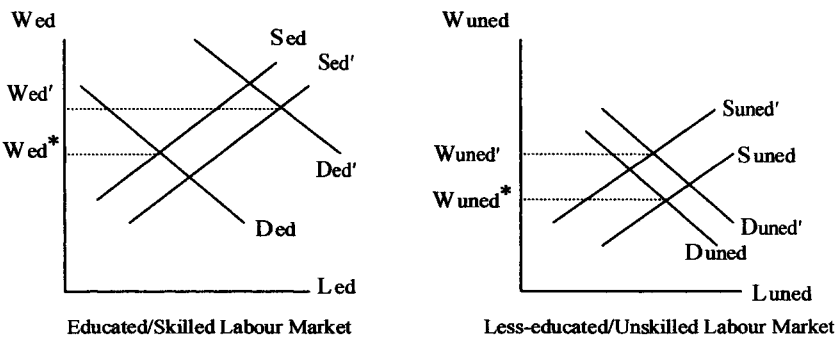

Figure 3.4 Shift in labour supply and labour demand curves

A convenient way of summarizing the argument is to adapt the analysis developed by Bound and Johnson (1992) as a means of explaining rising educated/less-educated wage differentials in the US; our adaptation of their basic diagram is illustrated in Figure 3.5. Initially, the supply of highly educated workers, relative to less-educated workers, is given by S, which is assumed to be invariant with respect to the relative wage W. The initial relative demand curve D depicts the demand by employers for highly educated workers, relative to less-educated workers. This demand is a decreasing function of W.

Equilibrium within the labour market is achieved when the relative demand is equal to the relative supply, producing relative employment E* and relative wage W*. In Taiwan, as in the US, rapid educational expansion shifted the relative labour supply curve to the right from S to S'. This, by itself, would have lowered the relative wage ratio to W^0; however, in Taiwan, the relative wage did not fall.[10]

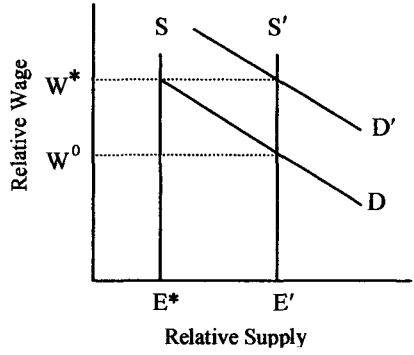

Figure 3.5 Relative supply and demand for educated labour

We can infer from the model that relative wages were maintained by a rightward shift of the relative labour demand curve from D to D'. This shift could have been produced by shifts in product demand in favour of the goods produced by skilled labour, exogenous shifts in the industrial wage structure, or changes in unmeasured labour quality.[11] If the rightward shift of the relative demand curve was of the same magnitude as the rightward shift of the relative supply curve, D' and S' would intersect at the same relative wage as before. This is an alternative way of demonstrating how educational wage differentials in Taiwan could have remained constant even though the labour force became much better educated.

Now, the twist on the theory! The two segments of the labour market have so far been treated as being entirely separate; that is, educated workers have been regarded as belonging to the skilled segment, and less-educated workers to the unskilled segment. However, as we have seen, a large and growing proportion of educated workers came to be employed in the lower-skilled occupations in Taiwan, and even after controlling for education, workers in Taiwan earn different amounts depending on the occupation in which they are employed. Clearly, therefore, both demand-side and supply-side factors come into play in explaining this particular phenomenon. On the demand side, workers with different educational attainments are substitutes for each other, albeit imperfect ones. If the relative wage for workers of a given educational category changes sufficiently, employers will have some incentive to substitute the relatively cheaper labour for labour which has now become relatively expensive. The demand for workers of a certain type would shift as a result of the changes in relative wages, with the amount of this shift being dependent on the elasticity of substitution between different types of labour in different occupations. This theory is developed in the models of Freeman (1980), Katz and Murphy (1992) and Bound and Johnson (1992), amongst others.

At the same time, there is also a supply-side effect. Workers do not invariably supply their labour to a given industry or occupation; rather, if employment and earning opportunities improve sufficiently in one part of the labour market, relative to another, there will be a resultant shift in relative supply. Thus, in Taiwan, many of the highly educated workers found that it was in their best interests to shift to semi-skilled occupations. Although they did not necessarily earn as much in these occupations as they might otherwise have done had they been able to secure employment in skilled occupations, it is precisely because not all of them could find employment in the skilled occupations that they took up employment in the less-skilled ones. In this way, jobs that might previously have been filled by high-school graduates came to be filled instead by college graduates. It may of course be quite feasible that workers in these middle-level occupations would continue to engage in job-search activities whilst in such employment; whether or not it would be in their best interests to do so would depend largely on the monetary and psychic costs of such job searching relative to the perceived benefits (Burdett, 1978).

CONCLUSIONS

In our examination of the Taiwanese labour market, putting the two sides of the market together, we find that it is quite plausible, and indeed perfectly consistent with the models, that the demand for labour increased for every labour category, thereby explaining why wages rose throughout the whole of the economy. Using data from the Manpower Utilization Survey to perform Katz and Murphy's inner-product test, in their attempt to explain Taiwan's changing wage structure, Gindling and Sun (2002) demonstrated that it was clear that changes in relative supply dominated changes in relative demand. These considerations point the way towards the development of an even more comprehensive analytical framework, with a more complete model involving the adaptation of the supply and demand analysis into a cross-classification of educational and occupational groups.

If we were to stick to just two educational groups and two occupational groups, the model would need four segments (skilled/educated, skilled/less-educated, unskilled/educated and unskilled/less-educated) as opposed to two. With three education groups and three occupational groups, as in the empirical work in this chapter, nine segments would be required, since the analysis would involve substitution across categories on the labour demand side, and mobility across occupations on the labour supply side. Adding industries to the analysis would, however, complicate the analysis exponentially. There is no such model at present for Taiwan, or for any other country for that matter; thus, the development of such a model lies at the frontiers of the research profession.

NOTES

1 Comprehensive details of these changes are provided elsewhere in this volume.

2 All figures are in constant (1991) New Taiwan dollars (NT$).

3 Although related, educational level is equivalent to neither ability nor productivity; earnings in the higher-skilled jobs will necessarily be higher in order to attract more capable workers, irrespective of their educational levels.

4 This approach was developed in DeBeyer and Knight (1989).

5 The 'Hours' variable is also included, since the dependent variable is monthly earnings rather than hourly wage.

6 Education is reported in the Manpower Utilization Survey in a small number of categories. Using these categories, we estimate the years of schooling for the potential experience variable as follows: (i) individuals with no education are estimated as having zero years of schooling; (ii) individuals educated to primary school level, or those who were self-taught, are estimated as having six years of schooling; (iii) those educated to junior high school level are estimated as having nine years of schooling; (iv) those educated to high school level (vocational or academic) are estimated as having 12 years of schooling; (v) those educated to junior college are estimated as having 14 years of schooling; and (vi) those educated to university level (or higher) are estimated as having 16(+) years of schooling.

7 It is important to note that occupational attainment functions do not constitute a model of occupational choice. An implicit assumption in this chapter is that workers may not succeed in gaining employment in their preferred occupations. Thus, occupational attainment functions are a means by which we can isolate the effects of education on occupational attainment from the effects of other included variables.

8 Occupational attainment functions were also estimated using potential experience instead of age, with similar results; however, the experience variable was insignificant in the semi-skilled equation.

9 The predicted probabilities are calculated as follows. For each educational level, the data is modified so that all observations are coded as having that particular educational level. Using this modified data, the probabilities of each occupational outcome are then predicted for every observation, with these probabilities then being averaged across the modified dataset in order to generate the predicted probabilities (reported in the table). This process is preferred to that of simply inserting the average values for the age and sex variables into the model, since it avoids the use of fractions, a number form that is never actually observed, in the sex variable.

10 There was a rise in the wage ratio between higher-educated and lower-educated workers in the US, which explains why our diagram differs slightly from that of Bound and Johnson (1992).

11 Any change in the demand for highly educated labour relative to less-educated labour brought about by changes in relative wages is a movement along the relative demand curve, not a shift of this curve.

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