Preliminary Draft

Demographic Transition, Human Capital and Wage Dynamics in Taiwan

Abstract

This paper examines the associations of both quantity and quality of labors over dramatic demographic transition with the growth and the distribution of labor income among prime–age males in a case study of Taiwan. Our results show that the growth of human capital both in education and working experience explained significantly large amount of wage growth over the 1978-2001 period. The wage inequalities between high-skilled and low-skilled labors were shrinking in Taiwan during 1988-1993 and became widening after 1994. A large increase in the relative excess demand for low-skilled workers during 1988-1993 is associated with the narrowing in college premium. By contrast, a considerable increment in the relative human capital stocks for college graduates since 1994 is associated with the widening in educational premium.

Key words: Human capital; Wage structure; Demographic transition
JEL classification: J31, I20

I. INTRODUCTION

Factor accumulations are documented as the fundamental causes in explaining the extraordinary postwar growth of East Asian NICs (Krugman 1994; Young 1991, 1995). Among those, the fast growth of human capital is especially postulated as an important key to the rapid and sustained growth experience of these countries. However, what is human capital? Human capital in empirical studies is usually measured as some indicators from formal school education (Benhabib and Spiegel 1994, Tallman and Wang 1994). If learning by doing is one of the important method in adapting technology for these countries during the past four decades, working experience could be an alternative form of human capital that significantly influence economic growth and economic distribution. With dramatic demographic transition and educational expansion of East Asian NICs, a huge number of higher educated laborers with growing working experiences flooded into the labor market during 1980's and 1990's. In this paper, we focus on a country study to provide a more careful and in-depth examination in how and how much education and working experience explain the growth and the distribution of labor income among labor inputs.

Taiwan, a successful emerging economy of East Asia with rapid economic growth, has gone through demographic transition and adopted liberalization and

technology-intensive industrial development policy since late of seventies. Like many of other developing countries, the total fertility rates in Taiwan dropped dramatically after World War II, from 6.5 children per women in 1955 to 1.7 children in 1987. Consequently, a huge number of young laborers flood into the labor market during the 1970s and the 1980s, and then passed into their mid-career during the 1990s (see Figure 1). The number of older laborers aged 40-49 rose significantly from 1.1 million in 1978 to 2.3 million in 1997. While, young labors aged 20-29 increased sharply during 1970s and 1980s from 0.9 million in 1965 to 2.4 million in 1987 and then declined slightly over the 1990s. Meanwhile, the educational sector in Taiwan has expanded radically. The number of laborers with junior college and above (i.e. at least fourteen years of schooling) increased from 0.5 million in 1978 to 2.2 million in 1997. While, the number of laborers with a junior high and below level of education (i.e. at most 9 years of schooling) declined from 4.7 million to 3.9 million over the same period. The significant demographic transition and educational expansion have significant impacts on wage structure in Taiwan.

In this study, we use a simple general equilibrium model explicitly incorporating both formal education and working experience into the wage determination framework. Prime-age males aged 25-64 are studied. Our paper is organized as follows. Section II examines the dynamics in wage structure and human

capital structure for prime-aged males (aged 25-64) during periods 1979-1987, 1988-1993, and 1994-2001. Section III sets up a simple model of general equilibrium to determine the wage premium. Section IV sets up an empirical model based on the theoretical model from Section III and reports the empirical results. Section V concludes the paper.

III. Dynamics in Wage Structure and Human Capital

A. Description of the Data

The data used for this analysis are obtained from a series of 24 consecutive Manpower Utilization Surveys (MUSs) in the Taiwan area for 1978-2001. The Manpower Utilization Surveys, conducted by the Directorate-General of Budget, Accounting and Statistics (DGBAS) Executive Yuan, R.O.C., provide information on monthly earnings, weekly hours worked, occupation and industry in relation to the current job. Some 40,000 to 60,000 different civilians aged 15 and above are interviewed each year. In order to have more accurate measurements on hourly wages, labor supply and working experiences, we focus on prime-aged males (aged 25-64) who work more than forty hours a week.

Three sets of time-series variables are created. They are hourly wages, the quantity of employment, and the human capital stock for each demographic group in each industry. In order to have enough observations to measure all the variables, we

classify the economy into sixty industries based on two-digit industry codes crossing with two-digit occupation codes. We also divide prime-aged males into three demographic groups. They are: high-skilled prime-aged males, medium-skilled prime-aged males, and low-skilled prime-aged males. The skill levels are classified based on the worker's education. High-skilled workers are the ones with at least sixteen years of schooling (college and above level of education). Medium-skilled and low-skilled workers are the ones with 12-14 years of schoolings (senior high school and both 3-years and 5-years vocational school level) and the ones with at most nine years of schooling (junior middle school and below level of education), respectively. The human capital stock includes both formal school education and working experiences.

All the data for each demographic group in each industry are calculated as the weighted average for that particular group. The weights are the MUS individual sample weights. The hourly wage is the weighted average of the individual's hourly wage (= monthly earnings / (weekly working hours * 4)). The monthly earnings are deflated or inflated based on the 1991 consumer price index. The quantity of employment is used to measure the aggregate amount of labor supplied. The labor supply is the weighted average of individual's working hours who worked weekly more than 1 hour with pay or fifteen hours without pay for that given group. The

education stock is the weighted average of years of schooling, and the working experience is the weighted average of working experience, which is defined as age-years of schooling-8[1].

B. Changes in wage structure and human capital

Table 1 depicts average annual growth rates of the real hourly wages, labor supply, and the average changes in human capital stocks (education and working experiences) for prime-aged males among periods of 1979-1987 (period I), 1988-1993 (period II) and 1994-2001 (period III). The annual growth rates of the real hourly wages and labor supply are calculated as log changes of the real hourly wages and employment the consecutive years. The annual changes in human capital stock for given demographic group are calculated as the differences of the stock of formal education and working experiences for the consecutive years. Our finding shows that the wages structures of prime-aged males are significantly different among these three periods, which might correspond to the structure changes in Taiwan during eighties and nineties.[2] At the first period (1979-1987), wages grow moderately and similarly

[1] In order to take into account the two-years' army service, working experience of males = age-years of schooling-8 (instead of –6).

[2] There are two significant liberalization and globalization policies in Taiwan since 1980. They are the financial liberalization in 1987 and the lifting the restriction both on indirect investment to the P.R.C. and on foreign workers in the early 1990s. The first structure change occurred in 1987 has been widely explored in the literature (Chan et al., Chan and Hsu 2001). The second structure change in early nineties, however, has not been paid attention.

for all skill-levels, ranging from 4.13 to 5.09 percentage annually. The growths of real wages do not create disparities among different skill levels. From 1988 to 1993, however, the wages among skill levels grow significantly rapid and different, ranging from 6.13 to 9.05 annually. Due to the relatively high wage growth of low-skilled males than other skill levels, income inequality among skill levels has been shrinking during this period. This income equality has caught much attention by economist in Taiwan (Chan et al. 1998, Chan and Hsu 2001). By contrast, the growth in real wages after 1994 is much smaller than the growth in real wages during the previous periods for all skill levels. The growth in real wages for high-skilled workers is much larger than that for low-skilled workers, which resulting in a widening in income inequality.

For comparison, we present the changes in both the labor supply (quantity) and human capital stock (quality) of prime-aged males in columns 2-4 of Table 1. When comparing the wage growth with the changes in the quantity and quality of labors during 1979-1987 and 1988-1993, we find that the human capital stock for high-skilled and medium-skilled workers has increased with a much larger amount during 1988-1993 than previous period, which might explain the rapid growth in hourly wages for these two groups. However, for low-skilled workers, their education stock is still increasing with a smaller magnitude. The drop in labor supply might be the causes of substantial increases in real wages for low-skilled workers during

1988-1993. After 1994, human capital stock of high-skilled and medium skilled workers increased faster than the previous two periods. The growth in real wages for these two skilled groups, however, has been dropped. The changes in product demand might be the causes. By contrast, the growth in real wages for low-skilled workers become negative after 1994, their human capital stock has been declined dramatically during this period.

To further explore the substantially high growth in real wages during period II and low growth during period III and consequently the changes in income inequality, we present changes in real wages, labor supply, and human capital stock of high-skilled laborers to low-skilled laborers by age during period II and period III in Table 2. It shows that the shrinkage in college premium during 1988-1993 was found mostly for both young (age 25-34) and middle-aged groups (age35-55). After 1994, the college premium substantially increased for middle-aged and old laborers (age 55-64). When comparing the relative wage growth between high-skilled and low-skilled laborers with their growths of labor supply and changes in human capital stock shown in columns 2-4 of Table 2, we find that both relative changes in labor quantities and qualities are larger for age 25-34 and age 35-54 than for age 55-64 during period II. While, during period III, relative changes in labor supply and human capital stock are considerable for old laborers, which might explain the skill premium for old laborers

occurred after 1994 but not in period II. Both relative labor quantities and qualities between high-skilled and low-skilled laborers are increased sizable during period II and period III. The college premiums, however, are shrinking during period II and widening in period III. Labor quantity might play bigger role during period II, while human capital dominate labor quantity in period III.

III. A SIMPLE FRAMEWORK FOR THE WAGE PREMIUM

In order to explicitly explore the effects of both quantity and quality of labors on the wage structures, which are documented above, we use an equilibrium model of the labor market to analyze the determination of the wage premium among different demographic groups.

Assume that the economy consists of *J* industries and *I* labor inputs and that the production technology in all industries exhibits constant returns to scale. We denote output in industry *j* by y^j and the labor input by $L^j = (l_1^j, ...l_I^j)$ where l_i^j is the number of *i*th labor inputs employed in industry *j*. Let big letters denote vectors, matrices, or functions, and small letters denote scalars. The production function, which is assumed to be twice differentiable, can be represented as follows:

$$y^j = a^j F^j(h_1^j l_1^j, h_2^j l_2^j, ...h_I^j l_I^j), \qquad (1)$$

where a^j is the technological efficiency of industry *j*, and $H^j = (h_1^j, ...h_I^j)$ is a vector of the factor-augmenting technological efficiency of labor inputs. Based on the assumption of constant returns to scale, the cost function in industry *j* is separable in terms of prices (wages) and the level of output, and can then be written as follows:

$$c^j(W^j, y^j, a^j, H^j) = G^j\left(\frac{w_1^j}{h_1^j}, \frac{w_2^j}{h_2^j}, \ldots\ldots\ldots\ldots \frac{w_I^j}{h_I^j}\right) \cdot \frac{y^j}{a^j}. \qquad (2)$$

$W^j = (w_1^j, w_2^j, \ldots\ldots\ldots, w_I^j)$ is a vector of market wages of I demographic labor inputs in industry j, and G^j is the unit cost function. By applying the Envelope Theorem (Shephard's Lemma), factor input demand for labor i in industry j becomes:

$$l_i^j = \frac{\partial c^j}{\partial w_i^j} = \frac{1}{h_i^j} G^{j\prime}\left(\frac{w_1^j}{h_1^j}, \ldots\ldots\ldots\ldots, \frac{w_I^j}{h_I^j}\right) \frac{y^j}{a^j}, \qquad (3)$$

where $G^{j\prime}$ are the partial derivatives of the unit cost function in industry j with respect to each group's own efficient wage w_i^j / h_i^j. Although none of the variables in a discrete-time framework are differentiable, we can express the changes in the demand for labor by using a linear expansion of a function around a point. Let $\dot{x} = \Delta \ln x / \Delta t = \ln x_{t+1} - \ln x_t$ denote a change in any variable x. The changes in factor input demand for demographic labor i in industry j may then be the following form:

$$\dot{l_i^j} = -\dot{h_i^j} + \sigma_{i1}^j(\dot{w_1^j} - \dot{h_1^j}) + \ldots\ldots\ldots + \sigma_{iI}^j(\dot{w_I^j} - \dot{h_I^j}) + (\dot{y^j} - \dot{a^j}), \qquad (4)$$

where $\sigma_i^j = (\sigma_{i1}^j, \ldots\ldots\ldots, \sigma_{iI}^j)$ is a vector of the compensated demand elasticity for the demographic labor input i in industry j. The change in factor demand is determined by the changes in the technological efficiency of the labor input, changes in output, the changes in the technological efficiency of the industry, and the pure substitution effects of changes in the wage.

Let $k_i^j = l_i^j / l_i$ be the share of the labor input i that is employed in industry j. In market equilibrium, the sum of industry-specific demands for labor input i from

equation (4) equal the total market supply of the input $\dot{l}_i$.[3]

$$\dot{l}_i = \sum_{j=1}^{J} k_i^j \dot{l}_i^j, \tag{5}$$

By substituting (4) in the equilibrium condition (5), the changes in market equilibrium employment equation for the labor input becomes:

$$\begin{aligned}\dot{l}_i &= -\sum_{j=1}^{J} k_i^j \dot{h}_i^j + \sum_{j=1}^{J} k_i^j \sigma_{i1}^j (\dot{w}_1^j - \dot{h}_1^j) + ... + \sum_{j=1}^{J} k_i^j \sigma_{iI}^j (\dot{w}_I^j - \dot{h}_I^j) + \sum_{j=1}^{J} k_i^j (\dot{y}^j - \dot{a}^j) \\ &= -\dot{h}_i + \sigma_{i1}(\dot{w}_1 - \dot{h}_1) + ...\sigma_{iI}(\dot{w}_I - \dot{h}_I) + v_i, \end{aligned} \tag{6}$$

where $v_i = \sum_{j=1}^{J} k_i^j (\dot{y}^j - \dot{a}^j) = \sum_{i=1}^{I} w_i^j l_i^j \left(\dot{l}_i^j + \dot{h}_i^j \right) \Big/ \sum_{i=1}^{I} w_i^j l_i^j$ represents the weighted sum of changes in real output product net out of the changes in technological efficiency. The proof of the second part equation can be found in appendix. Assume the factor-augmenting technological efficiency of labor inputs in industry *j*, h_i^j, being a function of schooling s_i^j and working experience $\exp_i^j$, and having the following form:

$$\ln h_i^j = a s_i^j + b \exp_i^j + c \exp_i^{j\,2}.$$

Then the changes in technological efficiency of labor input *i* become

$$\dot{h}_i = a \sum_{j=1}^{J} k_i^j ds_i^j + b \sum_{j=1}^{J} k_i^j d\exp_i^j + c \sum_{j=1}^{J} k_i^j d\exp_i^{j\,2}. \tag{7}$$

By plugging (7) into v_i and equation (6), we get

$$ds_i = \sum_{j=1}^{J} k_i^j \left[ds_i^j + \left(\sum_{i=1}^{I} w_i^j l_i^i ds_i^j \Big/ \sum_{i=1}^{I} w_i^j l_i^j \right) \right],$$

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[3] The labor force participation rates for prime-aged males in Taiwan during the study periods are well above 90 percent. It would be reasonable to ignore the labor supply behaviors of prime-aged males here, and assume the total market labor supply for each demographic group is predetermined by demographic factors.

$$d\exp_i = \sum_{j=1}^{J} k_i^j \left[d\exp_i^j + \left(\sum_{i=1}^{I} w_i^j l_i^i d\exp_i^j \Big/ \sum_{i=1}^{I} w_i^j l_i^j \right) \right],$$

$$d\exp_i^2 = \sum_{j=1}^{J} k_i^j \left[d\exp_i^{j\,2} + \left(\sum_{i=1}^{I} w_i^j l_i^i d\exp_i^{j\,2} \Big/ \sum_{i=1}^{I} w_i^j l_i^j \right) \right]. \quad (8)$$

Let $\dot{L} = (\dot{l}_1, ... \dot{l}_I)'$, $\dot{W} = (\dot{w}_1, ..., \dot{w}_I)'$, $\Delta S = \left(ds_1, ..., ds_I\right)'$, $\Delta\exp = \left(d\exp_1, ..., d\exp_I\right)'$, $\Delta\exp^2 = \left(d\exp_1^2, ..., d\exp_I^2\right)'$. We have a system of employment equations among demographic groups as follows.

$$\dot{L} = \Omega\dot{W} + \dot{D} - E_1\Delta S \; - E_2\Delta\exp - E_3\Delta\exp^2. \quad (9)$$

By inverting the demand system (8), we obtain a system of linear equations for the determination of equilibrium wages.

$$\dot{W} = \Omega^{-1}(\dot{L} - \dot{D}) + A\Delta S + B\Delta\exp + C\Delta\exp^2, \quad (10)$$

where Ω^{-1}, is a matrix of "elasticity of complementary" that measures the effect of excess supplies of factors on wages; and $A = \Omega^{-1}E_1$, $B = \Omega^{-1}E_2$, $C = \Omega^{-1}E_3$. The change in demand index $\dot{D} = (\dot{D}_1, ..., \dot{D}_I)$, where $\dot{D}_i = \sum_{j=1}^{J} k_i^j \left(\sum_{i=1}^{I} w_i^j l_i^j \dot{l}_i^j \Big/ \sum_{i=1}^{I} w_i^j l_i^j \right)$[4]. The change in real wages is then determined by changes in labor supply, changes in relative product demand, and changes in the technological efficiency of both inputs and industries, which are associated with the

[4] One widely used measure is the fixed-coefficient "manpower requirements" index (e.g., Freeman [1975, 1980]). This index measures the percentage change in the demand for a demographic group as the weighted average of percentage employment growth by industry. where the weights are the industrial employment distribution for the demographic group in a base period. It can be rewritten as $\sum_j (L_{jk}/(\sum_j L_{jk}))\cdot(\Delta L_j/L_j)$, where j indexes the industry, k indexes the demographic group, L_j is the total employment of all demographic groups in industry j. and L_{jk} is the employment of group k in industry j.

changes in schooling and working experiences. Thus, changes in the relative wages in the case of the *k*th labor input vs. *i*th labor input may be expressed as follows:

$$\left(\frac{\dot{w}_k}{w_i}\right) = \dot{w}_k - \dot{w}_i = (\Omega_k^{-1} - \Omega_i^{-1})(\dot{L} - \dot{D}) + \dot{B}_k - \dot{B}_i \qquad (11)$$

where Ω_k^{-1} is a row vector in the *k*th row of matrix Ω^{-1}, and $\dot{B}_k$ associates the changes in both schooling and working experience for group *k*. Obviously, the wage premium are determined by changes in relative labor supplied, changes in relative labor demand, and changes in the relative technological efficiency of input and industry.

IV. ECONOMETRIC ESTIMATION AND RESULTS

A system of estimative linear equations for the determination of equilibrium wages equations (10) can be expressed as follows.

$$\dot{W} = \Omega^{-1}(\dot{L} - \dot{D}) + A\Delta S + B\Delta \exp + C\Delta \exp^2 + \Sigma,$$

where $\Sigma = (\varepsilon_1, \varepsilon_2, ... \varepsilon_i)$ denotes a vector of residuals. The system of equilibrium wages has been corrected for the first order autocorrelation ($\varepsilon_{i,t} = \rho_i \varepsilon_{i,t-1} + u_{i,t}$). The seemingly unrelated regression estimation (SURE) with first order autocorrelation are applied.

The measurements of all the variables are based on the theoretical derivation in section III. The variables $\dot{W}$ and $\dot{L}$ are calculated as the weighted average of

growths in hourly wages and growths in working hours over sixty industries for each demographic group. The weights are the share of demographic labor inputs that are employed in each industry k_i^j. The demand index $\dot{D}$ from Section III, are computed as the weighted average of the growth in working hours over sixty industry, where the weights are the share of real output that each demographic group contributed to each industry.[5] The changes in both schooling and working experiences are imputed according to formula (8). Finally, the estimation results have been reported in Table 3. The means of wage growths ($\dot{W}$), excess supply ($\dot{L}$ - $\dot{D}$), and labor supply ($\dot{L}$), product demand ($\dot{D}$) and changes in human capital stocks among different skill levels during the entire period and during different periods are presented in Table 4. Female laborers are included to take into account the complementarity or substitution between male and female laborers.

The coefficient estimates of Ω^{-1}, representing partial elasticity of complementarity between two labor inputs, are shown in the first four rows of Table 3. The estimates of partial elasticity reveal the following. First, The diagonal estimates demonstrate that the excess supplies for demographic groups are negatively associated with their own wage growths. Most of them are statistically significant with sizable

[5] Under the constant return to scale assumption for the production function, the real output will distributed completely to the input factors. Since the input factors in this paper are labor inputs, real output changes will be approximated by the changes in real earnings for all individuals in a given year.

amounts, except for high-skilled workers. Among them, the excess supplies of low-skilled workers have the largest impacts on their own wages. While, the excess supplies of high-skilled workers have the smallest impacts. Second, the off-diagonal estimates shows that most of the cross partial elasticities of complementarity are negative and significant. It conceals that the growth in real wages for each skilled level is significantly and largely affected by the excess supplies of other skilled groups. And different skilled levels in Taiwan are the quantity-substitutes (q-substitutes) to each other.[6] Low-skilled workers are the largest substitutes to other skilled groups. Female prime-aged workers and high-skilled workers are highly substitutes to each other.

The rows 5 to 7 of Table 3 show the impacts of changes in human capital stock both in school education and working experience on the growth of real wages. Formal school education plays a sizable and significant role in determining the growth in real wages for every group. Working experience also largely and significantly affects the wage growths for most of skilled levels, except for medium-skilled males. The growth of real wages for medium-skilled males is significantly and largely determined by formal school education but not working experience. While, high-skilled and low-skilled males are substantially influenced by both education and working

[6] If the cross partial elasticities of complementarity is positive (negative), the corresponding two factors are defined as q-complements (q-substitutes) (Hicks 1970).

experiences. The growth rates of real wages are considerably lower after 1993. Two dummy variables, one for the period before 1994 and the other for the period after 1994, are used to capture the structure changes. After controlling for the wage determinations from labor supply, labor demand and human capital, the wage growths during periods I and II (before 1994) are significantly higher.

Table 4 presents the mean values of wage growth (column 1), excess supply including labor supply and labor demand (column 2), changes in formal education (column 3) and changes in working experiences (column 4) for different demographic groups during the entire period and sub-periods. Since excess supply equals labor supply minus labor demand, negative excess supply denotes the positive excess demand. Combining the information from table 3 and table 4, we find the following. First, for the entire period, the large increases in both formal education and working experience for high-skilled workers and large increase in formal education for medium-skilled workers largely determine the substantial growth in real wages for these two groups. The decline in human capital stocks for low-skilled workers, especially the decline in working experiences might explain their low growth rates of real wages. The large excess demand for low-skilled workers, mainly due to the decline in labor supply, considerably and positively contribute to their own wage growth and to those of other skilled groups.

Second, when we compare all variables for different periods, we know that real wages grow substantially higher during 1988-1993 and radically lower during 1994-2001 for all skilled groups. The dramatic decreases in excess demand during 1994-2001 mainly due to the large declines in labor demand might be the one of the major causes of drops in the growth of real wages. The slower increase in human capital stocks for medium-skilled workers during period III might also explain the their slower growth in real wages during this period. Again, the large declines in human capital stocks for low-skilled workers also largely determine the negative growth in their real wages.

Third, as we have demonstrated in previous section that college premium has been shrinking during 1988-1993 and becomes widening since 1994. Comparing the relative grow in excess supply and relative changes in human capital stocks between high-skilled workers and low-skilled workers during 1988-1993 and 1994-2001, we find that large excess demand for low-skilled workers during 1988-1993 might be the causes of narrowing in college premium during this period. By contrast, relatively large increments in human capital stock for high-skilled workers during 1094-2001 might be the main causes of widening college premium since 1994.

V. CONCLUSION

In this paper, we have explored the role of alternative human capital stocks –working

experiences on the growth and the distribution of labor incomes for different skilled groups. We use a simple general equilibrium model explicitly incorporating both formal education and working experience into the wage determination framework. Prime-age males aged 25-64 are studied.

We find that formal school education plays a sizable and significant role in determining the growth in real wages for every group. Working experience also largely and significantly affects the wage growths for most of skilled levels, except for medium-skilled males. The growth of real wages for medium-skilled males is significantly and largely determined by formal school education but not working experience. While, high-skilled and low-skilled males are substantially influenced by both education and working experiences. We also find that large excess demand for low-skilled workers during 1988-1993 might be the causes of narrowing in college premium during this period. By contrast, relatively large increments in human capital stock for high-skilled workers during 1994-2001 might be the main causes of widening college premium since 1994.

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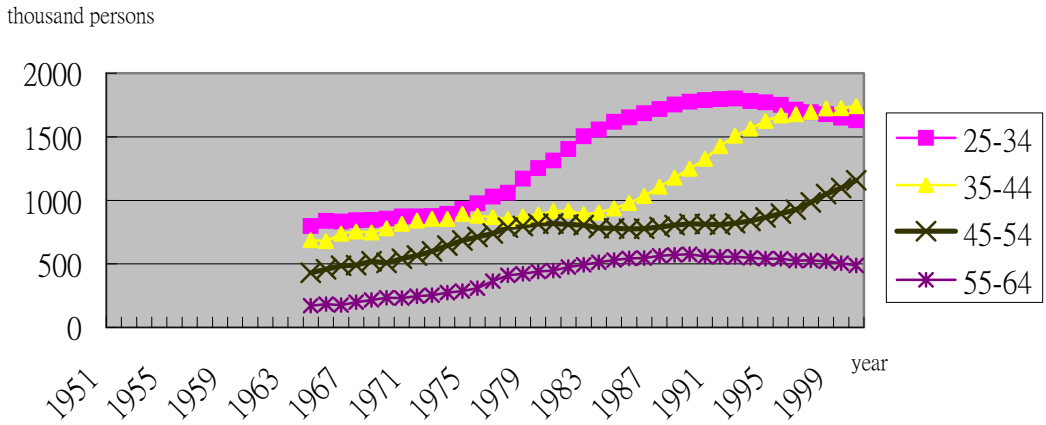

Figure 1. Time trend in number of male labors in Taiwan, 1966-2000

Table 1.Average changes in real hourly wages, labor supply, human capital for full-time prime-aged males in Taiwan 1979-2001.

Year	Demographic groups	Wage§ (percentage)	Labor supply§ (percentage)	Education¥ (ten thousand)	Working experience¥ (ten thousand)
1979 | 1987	High-skilled workers	5.09	4.23	16.63	10.14
	Medium-skilled workers	4.13	7.75	83.11	85.39
	Low-skilled workers	4.49	0.84	32.06	51.01
1988 | 1993	High-skilled workers	6.13	5.16	34.25	28.49
	Medium-skilled workers	7.68	5.70	113.54	151.42
	Low-skilled workers	9.05	-1.27	7.59	-28.98
1994 | 2001	High-skilled workers	2.05	4.30	44.42	38.79
	Medium-skilled workers	0.47	2.44	76.29	136.38
	Low-skilled workers	-0.01	-4.40	-45.66	-197.36

Data Source: Computed from Manpower Utilization Survey in Taiwan Area, 1979-2001.

Note: §: The numbers for both wages and labor supply are calculated as averaging the log changes in annual hourly wages and annual working hours for different demographic groups during periods of 1979-1987, 1988-1993 and 1994-2001

¥: The numbers for both education and working experience are calculated as averaging the changes in education stock and working experience stock for different demographic groups during periods of 1979-1987, 1988-1993 and 1994-2001

Table 2. Average changes in real hourly wages, labor supply, human capital for full-time prime-aged males in Taiwan by age 1979-2001.

Year	Demographic groups	Wage (percentage)	Labor supply (percentage)	Education (ten thousand)	Working experience (ten thousand)
1988	Age25-34				
	High-skilled workers	6.16	3.36	9.05	2.52
	Low-skilled workers	8.16	-3.54	-9.66	-42.63
	Age35-54				
	High-skilled workers	5.15	9.13	26.02	28.14
1993	Low-skilled workers	8.52	0.71	17.73	1.36
	Age55-64				
	High-skilled workers	7.59	-2.20	-0.56	-1.54
	Low-skilled workers	7.24	0.26	2.57	6.61
1994	Age25-34				
	High-skilled workers	0.45	3.47	14.59	3.63
	Low-skilled workers	-1.04	-9.49	-33.07	-56.57
	Age35-54				
	High-skilled workers	2.30	4.80	28.62	31.35
2001	Low-skilled workers	0.02	-2.55	2.74	-52.18
	Age55-64				
	High-skilled workers	4.63	4.65	3.55	6.52
	Low-skilled workers	0.66	-4.23	-5.96	-60.32

Same as table 1.

Table 3. The coefficient estimates (standard deviation) of wages equations for prime-aged workers

	High-skilled males	Medium-skilled males	Low-skilled males	Females
Excess supply ($\dot{L}-\dot{D}$):				
(1) High-skilled males	-0.275 (0.40)	-1.597 *** (0.53)	-0.765 (0.56)	-1.719 *** (0.57)
(2) Medium-skilled males	-4.015 *** (1.55)	-3.990 * (2.39)	-3.237 (2.20)	-6.550 *** (2.54)
(3) Low-skilled males	-9.966 *** (2.46)	-11.026 *** (4.32)	-11.467 *** (3.03)	-16.207 *** (3.19)
(4) Females	-5.333 *** (1.02)	-0.329 (1.72)	0.186 (1.80)	-3.435 * (1.95)
Education	0.780 ** (0.38)	1.515 *** (0.50)	0.969 *** (0.19)	1.577 *** (7.93)
Working Experience	0.100 * (0.06)	-0.106 (0.12)	0.424 *** (0.06)	
Working Experience^2	-0.002 ** (0.01)	0.003 (0.01)	0.004 *** (0.00)	
Time trend				-0.174 * (0.09)
Time Dummy (1979-1993=1)	0.054 *** (0.01)	0.046 *** (0.01)	0.013 (0.02)	0.035 ** (0.01)
Time Dummy (1994-2001=1)	-0.010 (0.01)	0.014 (0.01)	-0.004 (0.02)	0.030 (0.02)
Adjusted R^2	0.94	0.93	0.96	0.89
D-W	2.80	2.17	1.86	1.93
Number of Observations	23	23	23	23

Note: *significant at the 10% level, two-tailed test; ** significant at the 5% level, two-tailed test; *** significant at the 1% level, two-tailed test

Table 4.Average changes in real hourly wages, labor supply, human capital for full-time prime-aged males in Taiwan 1979-2001.

Year	Demographic groups	Wage[$] (percentage)	Excess Supply: (Labor supply) (Labor demand) (percentage)	Education[¥] (ten thousand)	Working experience[¥] (ten thousand)
Whole Period 1979 | 2001	High-skilled workers	4.50	-5.86 (4.50) (10.36)	30.89	24.90
	Medium-skilled Workers	5.35	-6.68 (5.35) (12.03)	88.68	120.35
	Low-skilled Workers	1.53	-13.26 (-1.53) (11.73)	-1.36	-56.25
1979 | 1987	High-skilled workers	5.09	-5.52 (4.23) (9.75)	16.63	10.14
	Medium-skilled workers	4.13	-1.10 (7.75) (8.85)	83.11	85.39
	Low-skilled workers	4.49	-5.61 (0.84) (6.45)	32.06	51.01
1988 | 1993	High-skilled workers	6.13	-15.24 (5.16) (20.40)	34.25	28.49
	Medium-skilled workers	7.68	-24.94 (5.70) (30.64)	113.54	151.42
	Low-skilled workers	9.05	-36.98 (-1.27) (35.71)	7.59	-28.98
1994 | 2001	High-skilled workers	2.05	0.72 (4.30) (3.58)	44.42	38.79
	Medium-skilled workers	0.47	0.79 (2.44) (1.65)	76.29	136.38
	Low-skilled workers	-0.01	-4.09 (-4.40) (-0.31)	-45.66	-197.36

Data Source: Computed from Manpower Utilization Survey in Taiwan Area, 1979-2001.