Sectoral Shifts, Natural Rate of Unemployment, and Female Labor Force Participation Rate: Evidence from Taiwan

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Abstract

Taiwan's female labor force participation rate has revealed cyclical movement in the short run since the 1960s. The cyclical variation in labor market seems related to recent industry structural shifts in Taiwan. We adopt Lilien's (1982) method to calculate the natural rate of unemployment, taking into account the shifts of demand for labor among different sectors. We then use Pancavel's (1986) method to run the regression of female labor force participation on the natural rate of unemployment. We find that the decision of female laborers is significantly sensitive to sectoral shifts, especially for the group of age 15-44.

JEL classification: J21, E32, E24

Keywords: Shifts in industrial structure, natural rate of unemployment, female labor force participation rate

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1.Introduction

The interaction between female labor supply and business cycle has been one of the main issues in the labor market since the 1960s. For most societies, women have to play an important role in the family. They are responsible for most household chore, bearing, rearing and educating children, and even share the financial burden with the husbands. Consequently, a female has more frequent entries and exits from the labor market than a male does. Therefore, to investigate the specific volatility of female labor in the short run becomes very important.

Many countries experience drastic structural changes during the process of economic development. Those countries transfer from an agricultural economy to an industrial one, and then from the industrial economy to a service economy. Figure 1.1 shows Taiwan's employment rate in the agricultural sector was around 50% during the 1960s. When demand for agricultural products went down, this primary industry became less important. As the island's secondary industry developed, the employment rate there increased from 20% in the 1960s to 30% and even exceeded that of the primary industry in the 1970s. During the 1970s most industries were engaged in labor-intensive production and the employment rate there was above 40%. By the 1980s, the tertiary industry started to expand and the employment rate there increased from 30% in 1960 to 50% in 1990.

During the process of industry structural shifts, the labor force has to reallocate among alternative sectors. Since labor reallocation is not instantaneous, it takes time for laid-off workers to be reemployed. Unemployment is the time during which workers withdraw from contracting firms and find employment in expanding firms. Hence, structural changes will lead to a cyclical unemployment movement, and it is especially significant after 1995 in Taiwan when there were large sectoral shifts. Therefore, one has to consider the factor of industry structural change while he/she studies the relationship between female

labor force participation and economic fluctuation.

Figure 1.1.   The employment rates by industry
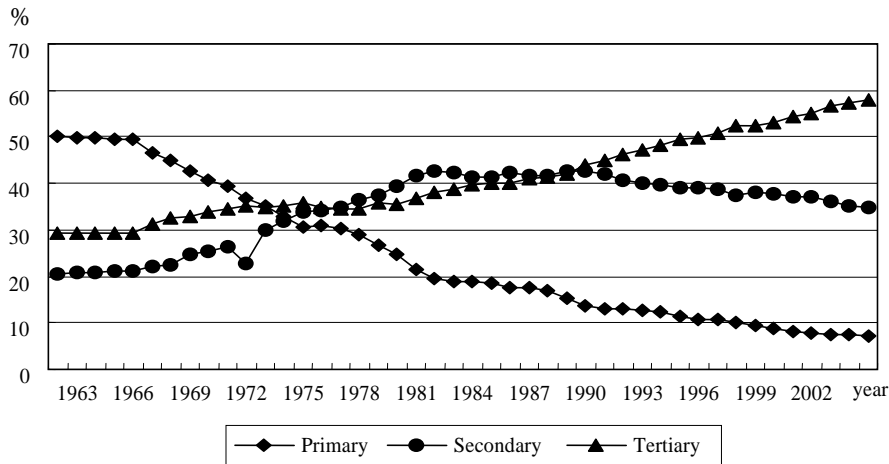
While economists examine the relationship between labor force participation and labor market fluctuation, there are mainly two approaches. The first is to study the behavior of individuals by focusing on the added-worker effect.   The second studies the added-worker effect and focuses on changes in the size of the aggregate labor force over time.   Our research follows the second approach, adopts aggregate time-series data, and discusses the net effects of employment conditions on participation rates, i.e., the discouraged-worker effect vs. the added-worker effect.[1]

Research studies along this line, however, economists disagreed with a good indicator of labor market fluctuation.   Strand and Dernburg (1964) use the ratio of employment as an indicator of economic fluctuation and decompose the labor force into different-age groups to see which group

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[1]   Most recent studies (after 1980) examine the presence of an added worker effect in individual households and have produced varied results. See Lundberg (1985) for a reference.

will retreat from the labor market during a recession.　They find that the discouraged effect dominates especially in the groups of women, youths, and older men.　Mincer (1966), however, criticizes on Strand and Dernburg's (1964) paper.　He points out that the employment ratio is a part of labor force participation, and will make the positive effect of the employment ratio on labor force participation extremely large beyond the negative effect.　This will result in an over-estimated bias.　Liu (1994) regresses the female labor force participation rate on the employment ratio, which serves as the indicator of the business cycle.　She finds that the coefficient is both positive and significant, but is also subject to the same problem as that in Strand and Dernburg (1964).

On the other hand, Bowen and Finegan (1965) and Cain (1964) use unemployment as an indicator of short-run variations in employment opportunities, and obtain a strong net negative sensitivity of labor force to unemployment.　Based on Taiwan's data from 1965 to 1977, Chang (1979) examines the responses of eleven different age groups of female laborers to a business cycle.　To measure the business cycle, he uses both the overall unemployment rate and the employment rate of the agricultural sector during that period.　He finds that whereas the labor force participation of women at a prime age is very sensitive to a business cycle, the labor force participation of teen-age girls is very sensitive to the school enrollment rate.

However, Elmeskov and Pichelmann (1993) disagree with overall unemployment rate being a feasible indicator in the sense that sometimes workers retreat from the labor market not to be an unemployed, but to be a non-participant.　If workers retreat to be an unemployed, the labor force responds negatively to unemployment and it happened in some OECD countries.　To be a non-participant, the labor force may not respond to unemployment at all.　Furthermore, the overall unemployment rate itself used to respond too much to a business cycle and amplifies the cycle's impact.

Pancavel (1986) uses the unemployment rate of men aged 35-44 instead of overall unemployment rate as an indicator of labor market

fluctuation. The unemployment rate of males from ages 35-44 is a good proxy for aggregate demand because of the low responsiveness of this group to the fluctuation in aggregate demand. Thereby, this group's behavior can indicate the economic fluctuation. However, Pancavel (1986) finds that different age groups have different responses, and the regression coefficients in his paper are not statistically significant.

Darby, Hart, and Vecchi (2001) use the business sector GDP as the indicator of aggregate demand fluctuation. The business sector GDP can reflect most of turning points of the business cycle for France, Japan, Sweden and the United States. They find the discouraged-worker effects are prevalent among women of ages 45-54.

Finally, Lilien (1982) discovers that in the 1970s U.S. sectoral shifts led to dramatic labor force reallocation and contributed to high unemployment. Lilien recalculates the natural rate of unemployment, considering the factor of sectoral shift. The natural rate will move up and down when a large sectoral shift exists. Hence, the natural rate of unemployment does not keep at a constant rate any more. In Taiwan, Hsu (1998) modifies Lilien's method to estimate the natural rate of unemployment (i.e. U_n), and finds that Lilien's U_n estimator could predict more correctly the reflection points and movement of a business cycle.

Sakata (2002) examines Lilien's sectoral shifts hypothesis for Japan. The paper finds that there is no evidence of a long-term relationship between unemployment and sectoral shifts, and obtains significant short-term effects of sectoral shifts on unemployment in recessions. Its results further confirm legitimately the natural unemployment rate being an indicator and considering sectoral shifts.

Our paper's contributions to the labor studies are as follows: (1) We are the first to examine the interaction between female labor force and economic fluctuation by considering the factor of sectoral shifts. (2) We can improve Pancavel's method by calculating the natural rate of unemployment as a regressor on female participation rate. (3) In terms of Taiwan data, our results confirm that the behaviors of female labor force

are very sensitive to structural shifts and the "discouraged-worker" effect dominates.

Based on Taiwan data from 1972 to 1999, we find it is not significant, using Pancavel's approach, to regress the female labor participation on the unemployment rate of males age 35-44.   On the other hand, using Lilien's U_n as the regressor, we obtain a significant relation between female labor force and economic fluctuation.   We can also confirm structural change does play an important role in explaining the fluctuation in female labor force participation.   Especially, those women of ages 15-44 respond very sensitively to sectoral shifts.   They will retreat from the labor force due to the rise of unemployment during the period of large sectoral shifts.   Those female laborers including married women behave as the theory expects.

Section II briefly describes the history of the business cycle, female labor participation rate, and unemployment rate in Taiwan.   We decompose the female labor force into eleven groups by age and adopt the method from Pancavel (1986).   There, we investigate the effect of unemployment on each group of female laborers, including the data from 1972 to 1999.   In section III we use the data to show the relationship between the shifts of intersectoral demand and the behavior of female labor force participation.   Furthermore, we use Lilien's (1982) method to derive the natural rate of unemployment and adopt Pancavel's approach to see how female laborers respond to the natural rate.   Section IV provides some discussion and concluding remarks.

2. The effect of the unemployment rate on the female labor force participation of different age groups

This section will overview the stylized facts of the unemployment rate and female labor force participation and investigate their relationship.

2.1 The data and the stylized facts

In Figure 2.1, we plot Taiwan's real per capita GNP growth rate and unemployment rate. The report from the Council for Economic Planning and Development of the Executive Yuan notes seven recessions from 1960 to 2003.   Due to the oil crisis, the recession during 1973-1975 was the most severe, as there was an upward trend in the unemployment rate following this severe recession.   We find that the unemployment rate moves in the opposite direction of the real GNP growth rate and lags one period.   Hence, previous research studies use the unemployment rate as a proxy for the business cycle.

Figure 2.1   The growth rate and unemployment rate in Taiwan
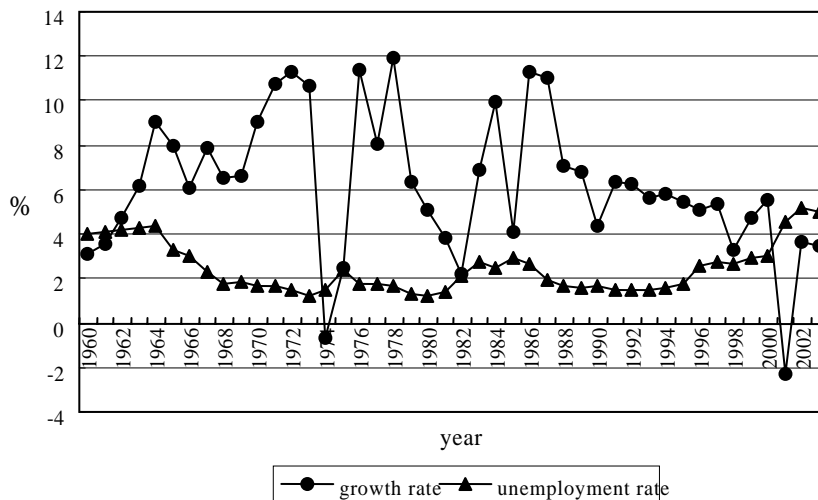
We similarly draw the time series of the unemployment rate and female labor force participation rate in Figure 2.2.   We find the female labor force participation rate fluctuates over time from 1956 to 2003. After 1973, the lowest female participation rate was 37.56% in 1976.   We

discover that the unemployment and female labor force participation rate move respectively in opposite directions.　Figure 2.2 seems to suggest that female labor supply does respond to an economic fluctuation.

Figure 2.2　The unemployment rate and female labor force participation rate in Taiwan

2.2　The model and the results

The method adopted by Pancavel (1987) is the easiest and most common way to compare how female laborers respond to short-run fluctuation in labor market.　Knowing that the result of U.S. data shows insignificance, we use the Taiwan data to see if the relationship between female labor force and business cycle exists.　We first divide all female laborers into eleven groups by age and see who will enter or withdraw from the labor market during a recession.

We collect annual aggregate labor force data from 1972 to 1999 and regress the difference in age-sex specific labor force participation on the

difference in the unemployment rates for males aged 35-44. The data source comes from Yearbook of Manpower Survey Statistics Taiwan Area, R.O.C. Previous labor studies show that in addition to unemployment, both female education and work experience can influence the behavior of female participation. For the sake of comparing the sensitivity among different cohorts of age, we do not include personal characteristics, such as education, as regressors. Using both the difference of female labor force participation rates and the unemployment rates can remove the serial correlation over time. Let us build up the model as

$$\Delta L_{ijt} = \alpha_{ij} + \beta_{ij}\Delta U_t^r + \varepsilon_{ijt}. \qquad (1)$$

In equation (1), we define $\Delta L_{ijt} \equiv L_{ijt} - L_{ijt\text{-}1}$ and L_{ijt} as the labor force participation rate of group age j of sex i, i = male, female, in year t. We also define $\Delta U_t^r \equiv U_t^r - U_{t\text{-}1}^r$ and U_t^r as the unemployment rate of men aged 35-44 in year t. A low unemployment rate means high job availability, and the costs of job search depend on job availability. The higher the unemployment rate is, the lower the job availability will be and the fewer workers there will be that enter the labor market. Therefore, unemployment rate U_t^r is expected to adversely influence the level of the participation rate.

The responsiveness of the participation rate to a business cycle is measured by β_{ij}. β_{ij} denotes the net effect of the discouraged worker effect over the added worker effect. The intercept α_{ij} reflects a linear time trend. The equation error is represented by $\varepsilon_{ijt.}$ Index j runs over eleven age groups and i over the two sex groups, male and female.[2] The outcomes of the estimation are shown in Tables 2.1 and 2.2.

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[2] Including male cohorts of different ages, we can understand how different the responsiveness to a business cycle between men and women.

Table 2.2.　The regressions of female labor force participation rates in different age groups on the unemployment rate of males ages 35-44 (1972 - 1999).

age (years)	α	β	Rsq	D-W
Female all	0.326 (1.302)	-0.0061 (-0.074)	0.0002	1.526
15-19	-1.537* (-7.429)	1.341* (2.044)	0.1432	1.755
20-24	0.503** (1.833)	-1.386 (-1.594)	0.0922	1.217
25-29	1.512* (3.892)	-1.389 (-1.128)	0.0485	1.788
30-34	1.037 (2.153)	-0.109 (-0.071)	0.0002	2.014
35-39	0.909* (2.065)	-0.382 (-0.274)	0.0030	1.723
40-44	0.735** (1.662)	0.399 (0.284)	0.0032	1.329
45-49	0.639* (2.111)	1.053 (1.100)	0.0462	1.154
50-54	0.482** (1.738)	0.600 (0.082)	0.0182	1.790
55-59	0.459** (1.905)	-0.028 (-0.035)	0.0001	2.404
60-64	0.585 (1.069)	-1.065 (-0.614)	0.0148	2.287
65+	0.098 (1.362)	0.051 (0.226)	0.002	2.347

Note -- *　denotes the 5% level of significance.
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　　　　( ) is the t-value.

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Table 2.1 shows the responsiveness of male participation rates in eleven age groups to fluctuations in the unemployment rate. Table 2.2 demonstrates the responsiveness of female participation rates in different age cohorts to the business cycle. In general, there is a strong secular up-trend in the participation rates of most female groups, except for the youngest group of 15-19 years old. The value of α_{ij} for the female cohort of age 15-19 is negative. It implies that more and more teen-age girls retreat from the labor market and go to school over time.

Male participation rates reveal similar downtrends among the groups of ages 15-19, 20-24, 40-44, and 50-59. However, most of the intercepts α_{ij} in Table 2.2 are larger in absolute value than those in Table 2.1. These evidences show that female labor force participation rates substantially increase over time, while male participation rates decrease over time.

Table 2.2 also shows that the values of β_{ij}s for women of ages 20-39 are negative and means that the participation rates of those women are procyclical. In a recession, the discouraged worker effect dominates, and those women will withdraw from the labor force. Moreover, the values β_{ij} for most age-specific male groups are negative, showing that, except for ages 15-19, 50-54, the male participation rates are procyclical. However, in most cases those coefficients β_{ij} are not significant, and it implies that the labor force participation in Taiwan is not very sensitive to cyclical movements in the unemployment rate. These insignificant results are parallel to those of U.S. data by Pancavel.

In contrast in Table 2.2 we do obtain that there is a strong secular up-trend in the participation rate among married women. Especially for the age cohort of above 20, the coefficient α_{ij} is relatively large. We find that most of the coefficients β_{ij} are negative, and it means the "discouraged-worker" effect dominates the "added-worker" effect. When a recession occurs, most adults withdraw from the labor market and stay home and therefore the labor force participation rate goes down. On the other hand, the participation rate of women 40-54 is counter-cyclical. During a recession, those women, after bearing children, will join the labor market and start to search for jobs.

The responses of both men and women from age 15 to 19 are also along the adverse direction of the business cycle.   This implies that their "added-worker" effect dominates the "discouraged-workers" effects, because in a recession those teenagers in low-income families may enter the labor market and search for jobs.

For most old men and women above 60, the trend does not go down over time.   This result differs from the trend of old people in the U.S..   It may be because, in Taiwan, social security for old people is not available, and they need to work and save for their retirement.

The influence of the business cycle on the total female labor force participation rate is procyclical, although it has an up-trend ($\beta = -0.0061$ and $\alpha = 0.326$).   Furthermore, notice that for the whole male labor force the situation works in reverse.   Although the sign of β_{ij} for all women is negative as expected, it is not significant.   Moreover, the response of the female labor force to the unemployment rate is not sensitive.   We believe that it is because the unemployment rate in Taiwan is relatively low and stable, and thus may not be a good proxy for economic fluctuation. [3] Chang (1979) also mentions this point and tries to make up the deficiency by adding the proportional of agricultural employment to total employment to the regression.   In the next section we try to find another proxy for a business cycle so that we may have more significant results.

3. The relationship between shifts in intersectoral demand and female labor force participation

3.1 Stylized facts

Since   1960   the   structure   of   Taiwan's   industries   has   changed

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[3]   We extend the data set to 2003 and run the same regression, and find the result is not significant, either.   Please see Table A.2. and Table A.3. in the Appendix.

substantially, resulting in the fluctuation of labor market and changing the decision of female labor force participation.   The female labor force participation rate was 18.3% after World War II.   By 1953 most women worked on the farm and the participation rate had climbed to 39.85%, because they could take care of their children as well as work on the farm. When the demand for agricultural products decreased, the female participation rate dropped to 32.57% in 1966.

As the secondary industry developed, the job opportunities for women increased, unemployment rate went down, and the female labor force participation rate rose to 41.53%.   When the production of manufacturing industries transferred from labor-intensive to technology-intensive, the female labor force participation rate fell down to 38.76% in 1981 while the tertiary industry started to expand.   More jobs became available for women and the female participation rate rose again.   The behavior of female participation is obviously affected by shifts in industrial structure.

3.2 The measurement of the natural rate of unemployment

Now we follow the definition of Lilien (1982) to derive the natural rate of unemployment.   Based on the natural rate hypothesis, most economists view cyclical unemployment as deviations from some constant natural rate.   Lilien asserts that a substantial fraction of cyclical unemployment is better characterized as fluctuations of the "natural rate". Since shifts of employment demand between sectors of the economy necessitate continuous labor reallocation and it takes time for workers to find new jobs, some unemployment is inevitable.   In Taiwan most of unemployment fluctuations are also induced by unusual structural shifts.

According to Lilien's assumption, the level of unemployment is not only affected by the size of the flow into unemployment, but also by the duration of an individual's unemployment spell.   The flow into unemployment depends on the speed with which workers find new jobs in expanding sectors.   The speed of finding new jobs further depends on the dispersion of employment demand conditions throughout the labor market.

Lilien constructs a proxy for σ_t to measure the dispersion of employment demand as follows:

$$\sigma_t = [\sum_{i=1}^{8} \frac{x_{it}}{x_t} (\Delta log\ x_{it} - \Delta log\ x_t)^2]^{\frac{1}{2}} \qquad (2)$$

where x_{it} is the employment rate in industry i and x_t is the aggregate employment rate in period t. While Lilien (1982) uses 11-industry, we use the 8-industry decomposition of aggregate employment from 1968 to 1999. [4]

The flow out of unemployment depends on last period's unemployment and unemployment duration. Most theoretical and empirical studies on search and contract theories support that unanticipated monetary policy affects unemployment duration. Let us use term DMR as a measure of unanticipated monetary policy defined by Barro (1977). Therefore, we can estimate the money growth equation as follow:

$$dM = c_0 + c_1 dM_{t-1} + c_2 dM_{t-2} + c_3 dM_{t-3} + c_4 fed_t + c_5 fed_{t-1}$$
$$+ c_6 U_{t-1} + c_7 U_{t-2} + \eta_t \qquad (3)$$

where dM denotes the change of money supply M1a, fed is the real expenditure of central government, and U is the unemployment rate. We derive the value of expected money growth dM_e. Finally we can obtain the unexpected money growth by DMR= $dM_e - dM$. According to above assumption, we yield an equation for the unemployment rate as follows:

$$U_t = a_0 + a_1 \sigma_t + a_2 \sigma_{t-1} + a_3 DMR_t + a_4 DMR_{t-1} + a_5 DMR_{t-2}$$
$$+ a_6 U_{t-1} + a_7 T + \varepsilon_t. \qquad (4)$$

In (4), T is a time trend to capture demographic and other changes that may have occurred in the labor market over the period. We now proceed to

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[4] The 8 industries include primary, mining & quarrying, manufacturing, electricity gas & water, construction, wholesale retail & restaurant, transport storage & communication, and service industry.

run the regression to derive those values of a_i.   Since natural rate of unemployment is affected by sectoral shifts, not by unexpected monetary growth, we let DMR and ε in (4) be zero, and we calculate out the natural rate of unemployment U_n.   We then adopt Lilien's natural rate instead of the unemployment rate of men aged 35-44 to run the regression as equation (1).   In the next subsection, we thereby are able to see how the sectoral shifts in demand affect the behavior of female labor force participation.

3.3 The effect of shifts in intersectoral demand on the female labor force participation rates of different age groups

We rewrite equation (1) by replacing U_t^r with U_n as follows:

$$\Delta L_{ijt} = \alpha_{ij} + \beta_{ij} \Delta \, Un + \varepsilon_{ijt} \tag{5}$$

and run the regression with respect to different sexes i and ages j.   The results are reported for male and female respectively in Table 3.1 and Table 3.2.   Table 3.1 shows the responsivenesses of the male participation rate in eleven age groups to fluctuations in the natural rate of unemployment. It is worthy to note that the value of α_{ij} for all men is smaller than that in Table 2.1 and the former is not significant, either.   In general, in Table 3.1 there is a secular downtrend in the participation rates of most male groups, except for the groups of ages 25-29, 35-39, and over 60.

Most of the coefficients β_{ij} in Table 3.1 are negative and their absolute values are greater than those of Table 2.1.   It tells that the behavior of the whole male labor force is procyclical and responds to the fluctuation in sectoral demand more sensitively.   The procyclical groups include the ages of 15-19, 25-39, 45-49, 55-59, and 60-64, especially the group of 25-29 is the most sensitive, because those males' job attachment is quite low after finishing their mandatory military stint.[5]   Their behavior is explicitly sensitive to shifts in sectoral demand.   While large sectoral

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[5]   The absolute value of β for the males of ages 35-44 is relatively small.   It confirms the common belief that the primary labor force does not respond to business cycle sensitively.

shifts result in the rise in unemployment, most men will withdraw from the labor market, especially men of ages 25-29.

Table 3.1.   The regressions of male labor force participation rates in different age groups on natural rate (1972-1999).

age (years)	α	β	Rsq	D-W
male				
all	-0.263**	-0.022	0.0009	2.162
	(-2.744)	(-0.146)		
15-19	-1.156*	-0.042	0.0004	2.272
	(-4.453)	(-0.105)		
20-24	-0.786*	0.467	0.0540	2.284
	(-3.104)	(1.195)		
25-29	0.048	-12.029**	0.1057	2.069
	(0.011)	(-1.719)		
30-34	-0.088	-0.771**	0.1295	1.742
	(-0.340)	(-1.928)		
35-39	0.094	-0.346	0.0243	1.629
	(0.332)	(-0.788)		
40-44	-0.103	0.071	0.0220	2.256
	(-1.679)	(0.749)		
45-49	-0.059	-2.898	0.0064	2.953
	(-0.013)	(-0.401)		
50-54	-0.127	0.596	0.0383	1.854
	(-0.329)	(0.998)		
55-59	-0.144	-0.372	0.0383	1.831
	(-0.598)	(-0.998)		
60-64	0.323	0.146	0.0014	1.411
	(0.645)	(0.188)		
65+	0.067	-0.099	0.0037	1.969
	(0.320)	(-0.305)		

Note -- * denotes the 5% level of significance.
       ** denotes the 10% level of significance.
       ( ) is the t-value.

Table 3.2.　The regressions of female labor force participation rates in different age groups on the natural rate (1972-1999).

age (years)	α	β	Rsq	D-W
Female all	0.348 (1.578)	-0.932* (-2.733)	0.2300	1.632
15-19	-1.430* (-6.934)	-0.535** (-1.679)	0.1013	1.884
20-24	0.417 (1.627)	-0.872* (-2.201)	0.1624	1.293
25-29	1.440* (4.514)	-1.700* (-3.448)	0.3222	1.918
30-34	1.057* (2.524)	-1.627* (-2.513)	0.2017	2.088
35-39	0.905* (2.332)	-1.411* (-2.352)	0.1812	1.818
40-44	0.787* (1.980)	-1.294* (-2.107)	0.1509	1.444
45-49	0.724* (2.450)	-0.448 (-0.982)	0.0372	1.127
50-54	0.528** (1.943)	-0.141 (-0.337)	0.0045	1.793
55-59	0.451** (1.953)	0.308 (0.862)	0.0288	2.379
60-64	0.510* (2.721)	-0.154 (-0.532)	0.0112	1.492
65+	0.102 (1.469)	-0.05 (-0.461)	0.0084	2.359

Note -- *　denotes the 5% level of significance.
　　　**denotes the 10% level of significance.
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Compared to those in Table 2.2, most coefficients α_{ij} and β_{ij} in Table 3.2 are larger and more significant.   In general, there is a strong secular up-trend in the participation rates of most female groups, except for the youngest group of 15-19 years old.   Table 3.2 also suggests that the participation rates of women from those groups of age 20-54 and 60 + are procyclical.   Because β_{ij}s of females are negative and the absolute value of β_{ij} are greater than those for the males, it follows that the behavior of female labor force participation responds to sectoral shifts more sensitively than that of males.   It also shows that the female labor supply is adversely affected by the change in industrial structure.   In the process of substantial sectoral change, if it takes more time for women to move from contracting sectors to expanding sectors, most women will leave the labor market and stay home.

4. Discussion and conclusion

From 1960 onwards, Taiwan's economy has been in the process of a large industry structural change.   The structural change has resulted in cyclical unemployment and has affected the decision of labor force participation.

While we use the unemployment rate of males aged 35-44 as an indicator for aggregate demand, we find that the labor force participation rate for all women as a group in Taiwan responds to cyclical factors.   We also find that women in different age groups do have different responses to the business cycle. However, most of the critical coefficients are not significant, and the result is similar to U.S. outcome. As such, we conclude that the unemployment rate for males aged 35-44 does not completely reflect the trend of sectoral shifts in Taiwan.

We then use Lilien's definition to measure the natural rate including sectoral shifts, and we see that the responsiveness of the female labor force from 1972 to 1999 is very sensitive and significant.   The outcome shows that sectoral shifts explicitly affect the willingness of labor force

participation for women aged 15-44 and men aged 25-29.   When the demand for sectoral employment changes substantially, the unemployment rate goes up, and these workers will withdraw from the labor force.   This means that their discouraged-worker effect dominates added-worker effect. They are the so-called "secondary workers".   Their payoff is relatively low, and so they have more choices to select.   For example, during a recession, a teenager and young people will choose to attend school, but not look for a job.   Similarly, married women will choose to stay home, but not go to work.

During the period of industry structural change, based on our study we proclaim that the government need to help those discouraged workers, i.e., women of age 15-44 and men of age 25-29.   Those workers' withdrawal from the labor force leads to under-utilization of labor and waste of human resource.   The government can create more job opportunities to attract those workers to stay in the labor force and search for jobs.   On the other hand, the government does not have to worry that much on those added workers.   They will join the labor market while their family incomes decrease due to sectoral shifts.

Finally, sectoral shifts do not always contribute to labor market fluctuation.   The variation of labor market may be affected by other factors, such as   institutional changes or geographical shifts.   Even when Lilien's natural rate is an appropriate indicator for business cycle according to the data from 1972 to 2003, we could not obtain the same outcome. (See Figure A.1. and Figure A.2. in the Appendix.).   This is because sectoral shifts can not explain most of labor market fluctuation. (See the Table A.4. and A.5. in the Appendix.)   We suspect that the industry structural change is not the main factor influencing the behavior of labor participation after 1999.   Especially in 1999 Taiwan's government starts the system of unemployment insurance, and this system changes the willingness of labor force participation.   While we adopt natural rate as an indicator of labor market fluctuation, we have to consider the institutional factors, monetary policy and some unexplained factors.   This belongs to another researches in the future.

Appendix

Table A.1.   The data for Figure 2.2

year	unemployment rate	female labor	year	unemployment rate	female labor
1956	3.64	37.50	1980	1.23	39.25
1957	3.73	37.10	1981	1.36	38.76
1958	3.80	36.96	1982	2.14	39.30
1959	3.88	36.81	1983	2.71	42.12
1960	3.98	36.37	1984	2.45	43.30
1961	4.10	35.81	1985	2.91	43.46
1962	4.17	35.01	1986	2.66	45.51
1963	4.26	34.73	1987	1.97	46.54
1964	4.34	34.11	1988	1.69	45.56
1965	3.29	33.11	1989	1.57	45.35
1966	3.02	32.57	1990	1.67	44.50
1967	2.29	33.72	1991	1.51	44.39
1968	1.72	34.36	1992	1.51	44.83
1969	1.88	35.38	1993	1.45	44.89
1970	1.70	35.45	1994	1.56	45.40
1971	1.66	35.37	1995	1.79	45.34
1972	1.49	37.07	1996	2.60	45.76
1973	1.26	41.53	1997	2.72	45.64
1974	1.53	40.22	1998	2.69	45.60
1975	2.40	38.56	1999	2.92	46.03
1976	1.78	37.56	2000	2.99	46.02
1977	1.76	39.14	2001	4.57	46.10
1978	1.67	39.13	2002	5.17	46.59
1979	1.27	39.23	2003	4.99	47.14

Table A.2. The regressions of male labor force participation rates in different age groups on the unemployment rate of males ages 35-44 (1972 - 2003).

age (years)	α	β	Rsq	D-W
male all	-0.272 (-3.102)	-0.238 (-1.248)	0.0510	2.174
15-19	-1.215* (-5.156)	0.276 (0.539)	0.0099	2.319
20-24	-0.914* (-3.520)	-0.300 (-0.533)	0.0097	2.021
25-29	0.160 (0.037)	-2.157 (-0.338)	0.0039	2.058
30-34	0.015 (0.065)	-1.083* (-2.145)	0.1369	1.931
35-39	0.097 (0.377)	-0.413 (-0.741)	0.0186	1.652
40-44	-0.133* (-2.204)	-0.128 (-0.979)	0.0320	2.148
45-49	0.269 (0.064)	-3.353 (-0.366)	0.0046	3.028
50-54	-0.206 (-0.568)	-0.130 (-0.165)	0.0009	1.993
55-59	-0.230 (-0.979)	-0.795 (-1.561)	0.0775	1.660
60-64	0.213 (0.460)	-0.993 (-0.990)	0.3270	1.482
65+	0.076 (0.400)	-0.184 (-0.443)	0.0067	2.000

Note -- *   denotes the 5% level of significance.
　　　** denotes the 10% level of significance.
　　　( ) is the t-value.

Table A.3.   The regressions of female labor force participation rates in different age groups on the unemployment rate of males ages 35-44 (1972 - 2003).

age (years)	α	β	Rsq	D-W
Female all	0.337	-0.099	0.0014	1.526
	(1.487)	(-0.202)		
15-19	-1.459*	0.774**	0.1099	1.701
	(-7.741)	(1.892)		
20-24	0.333**	-0.564	0.0330	1.305
	(1.274)	(-0.995)		
25-29	1.464*	-0.867	0.0446	1.816
	(4.367)	(-1.164)		
30-34	1.074*	-0.001	0.0000	2.015
	(2.542)	(-0.001)		
35-39	0.894*	-0.053	0.0001	1.768
	(2.294)	(-0.062)		
40-44	0.742**	-0.073	0.0003	1.312
	(1.906)	(-0.087)		
45-49	0.641*	0.351	0.0119	1.145
	(2.340)	(0.590)		
50-54	0.566*	-0.224	0.0056	1.769
	(2.226)	(-0.406)		
55-59	0.405**	-0.462	0.0307	2.357
	(1.826)	(-0.958)		
60-64	0.506*	-0.577	0.0694	1.549
	(2.798)	(-1.471)		
65+	0.103	-0.070	0.0086	2.316
	(1.594)	(-0.502)		

Note -- * denotes the 5% level of significance.
    ** denotes the 10% level of significance.
    ( ) is the t-value.

Table A.4.   The regressions of male labor force participation rates
in different age groups on natural rate (1972-2003).

| age (years)	α	β	Rsq	D-W
male all	-0.289** (-2.959)	-0.071 (-0.348)	0.0045	2.120
15-19	-1.175* (-4.838)	-0.031 (-0.059)	0.0001	2.301
20-24	-0.873* (-3.302)	-0.482 (-0.853)	0.0245	2.194
25-29	1.647 (0.383)	-11.610 (-1.263)	0.0195	2.141
30-34	-0.179 (-0.701)	0.366 (0.673)	0.0154	1.882
35-39	0.194 (0.763)	-0.916 (-1.689)	0.0895	1.659
40-44	-0.102 (-1.769)	-0.289 (-2.346)	0.1595	2.122
45-49	-0.702 (-0.162)	3.422 (0.370)	0.0047	2.995
50-54	-0.112 (-0.303)	-0.684 (-0.870)	0.0255	1.877
55-59	-0.280 (-1.124)	-0.298 (-0.560)	0.0107	1.556
60-64	0.220 (0.461)	-0.807 (-0.793)	0.0212	1.334

Note -- *   denotes the 5% level of significance.
     ** denotes the 10% level of significance.
     ( ) is the t-value.

Table A.5.   The regressions of female labor force participation
rates in different age groups on natural rate (1972-2003).

| age (years)	α	β	Rsq	D-W
Female all	0.235	0.725	0.0742	1.580
	(0.996)	(1.471)		
15-19	-1.424*	0.376	0.0255	1.650
	(-7.035)	(0.871)		
20-24	0.161	0.627	0.0401	1.175
	(0.603)	(1.101)		
25-29	1.192*	1.020	0.0606	1.771
	(3.412)	(1.368)		
30-34	0.906	1.036	0.0432	2.082
	(2.137)	(1.144)		
35-39	0.716	1.056	0.0527	1.881
	(1.840)	(1.270)		
40-44	0.609	0.767	0.0279	1.334
	(1.545)	(0.912)		
45-49	0.594	0.559	0.0295	1.257
	(2.133)	(0.939)		
50-54	0.438	0.619	0.0423	1.929
	(1.710)	(1.131)		
55-59	0.278	0.434	0.0266	2.292
	(1.216)	(0.890)		
60-64	0.426	0.052	0.0006	1.342
	(2.214)	(0.127)		
65+	0.052	0.262	0.1176	2.119
	(0.827)	(1.966)		

Note -- *   denotes the 5% level of significance.
          ** denotes the 10% level of significance.
          ( ) is the t-v9alue.

Figure A.1.　The actual unemployment rate and the natural rate
(1972-1999)
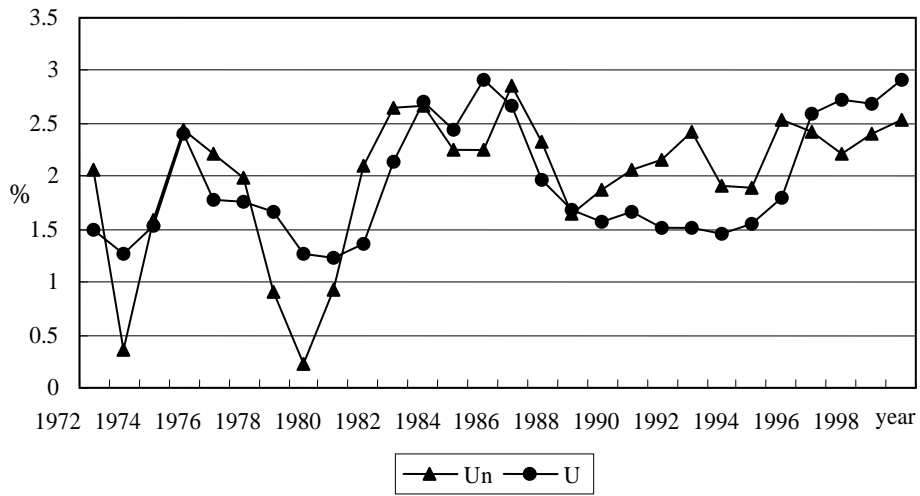
Note: The data of Figure A.1. include actual unemployment rate and
natural rate of unemployment estimated from 1972 to 1999.　We
can find that the trend of natural rates of unemployment mostly
follows that of the actual unemployment rates.

Figure A.2.   The actual unemployment rate and the natural rate
(1974-2003)
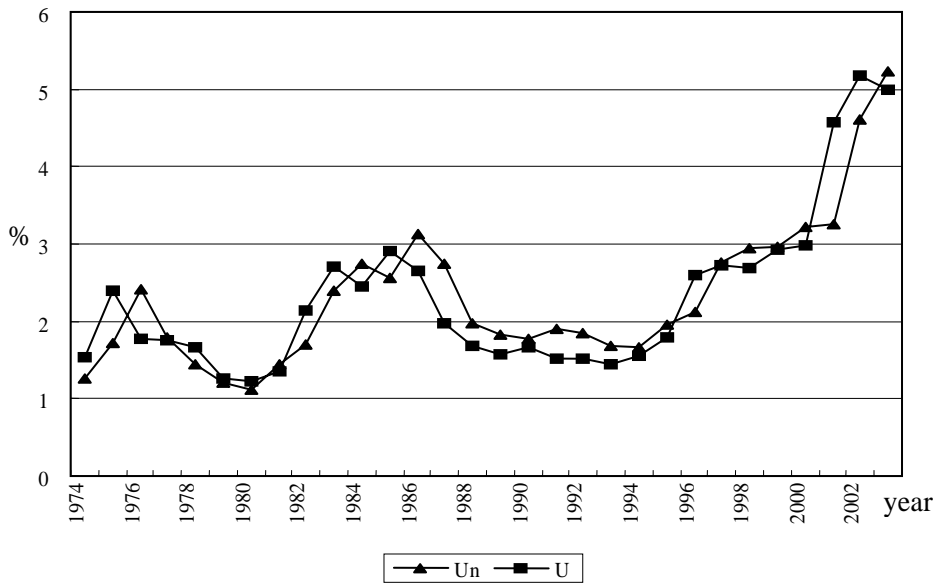
Note: The data of Figure A.2. include actual unemployment rate and
natural rate of unemployment estimated from 1972 to 2003.   We
can find that the trend of natural rates of unemployment mostly
follows that of the actual unemployment rates.

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台灣的產業結構變動，自然失業率，與婦女勞動參與率

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摘　　要

　　自從一九六〇年代起，台灣的婦女勞動參與率一直呈現短期循環波動的情形。這種勞動市場的波動似乎與台灣近年來的產業結構變動有關。於是本研究採用 Lilien (1982) 的方法計算自然失業率，他的自然失業率的計算包含不同部門間勞動需求變動的因素。然後再使用 Pancavel (1986) 的方法將婦女勞動參與率對自然失業率做迴歸。研究顯示 15～44 歲婦女的勞動參與決策對產業結構的變動非常敏感，也就是婦女勞動參與的短期波動深受產業結構變遷的影響。

JEL 分類代號：E24，E32，J21
關鍵詞：產業結構的變動、自然失業率、婦女勞動參與率