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THE SOURCES OF TAIWAN'S REGIONAL UNEMPLOYMENT: A CROSS-REGION PANEL ANALYSIS*

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Abstract

In recent years under the trend of a global recession and domestic structural change, the unemployment rate in Taiwan has reached a record high of above 5% which in turn has generated a series of social problems. Unemployment has now become the core issue in the government's agenda. From historical regional data, we find that there are distinct variations of the unemployment rate among 23 cities and prefectures; moreover, this differentiation seems to persist over time. We analyze this regional unemployment trend by equilibrium and disequilibrium factors controlling for the macro environment using 23 cities' and prefectures' cross section and time series data pertaining to the 1995 to 2004 period. A cross-region panel study shows that the major factors that explain the persistent but divergent regional unemployment rates (aside from the aggregate macro environment which explains about one quarter) are demographic composition, family characteristics, industrial structure, population density, migration costs, and labor mobility. Understanding the sources of regional unemployment will help us to determine the appropriate policies to mitigate the unemployment rate across regions.

Keywords: Unemployment Rate, Demographic Composition, Compensating Wage Differentials, Urbanization, Labor Mobility, Migration;
JEL Classification: E24, J23, J60

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I. *Introduction*

Ever since the 1960s except for the two oil crises, Taiwan's economy has achieved outstanding performance as its GDP has continued to grow steadily at an average annual growth rate of 8% and its unemployment rate has been confined to between 1.5% to 2.0%, nearly approaching full unemployment. However, from the second quarter of 1995 unemployment has increased significantly, with the number of unemployed increasing from 165 thousand in 1995 to 454 thousand in 2004 and the unemployment rate surging from 1.79% to 4.4%, more than doubling. An increase in the unemployment rate not only implies a serious underutilization of manpower, but also may likely generate a series of social problems in the long run.[1] As such, dealing with the upsurge in the unemployment rate has become the top priority in the government's policy agenda.

Aside from the rise of the aggregate unemployment rate, the regional unemployment rate in Taiwan shows various discrepancies. Between 1987 and 2004, the unemployment rate among Taiwan's 23 regions showed great variations and followed a persistent trend over time. The major high unemployment rate regions focus on city, municipality, and the eastern region. Figure 1 shows the average annual unemployment rate of Taiwan's 23 regions. The highest average unemployment rate is in Keelung City (3.71%) and the lowest rate is in Hsinchu Prefecture (1.48%), a deviation of more than two-fold, which confirms that a great discrepancy does exist among Taiwan's regions.

Table 1 depicts Spearman's rank correlation coefficients of the unemployment rates over time among Taiwan's 23 regions. Even though for the periods over ten years the correlation coefficients became weak, we find a high rank correlation between years within a ten-year period; for example, the rank correlation coefficient in our research period between 1995 and 2000 is 0.66, 2000 and 2004 is 0.58, and 1995 and 2004 is 0.51, respectively. As a ten-year period is usually considered as a long run phenomenon, these results imply that a persistent divergence trend exists among Taiwan's regional unemployment rates, whereby regions with a high unemployment rate stay high and regions with a low unemployment rate stay low. Moreover, Figure 2 shows that the range of deviations of Taiwan's regional unemployment rates is between 0.067 and 0.843 with an average of 0.363, showing a declining trend before the early 1990s followed by an increasing trend after the mid-1990s and then a declining trend again after 2000.[2]

The persistent deviation of regional unemployment rates has been identified in numerous

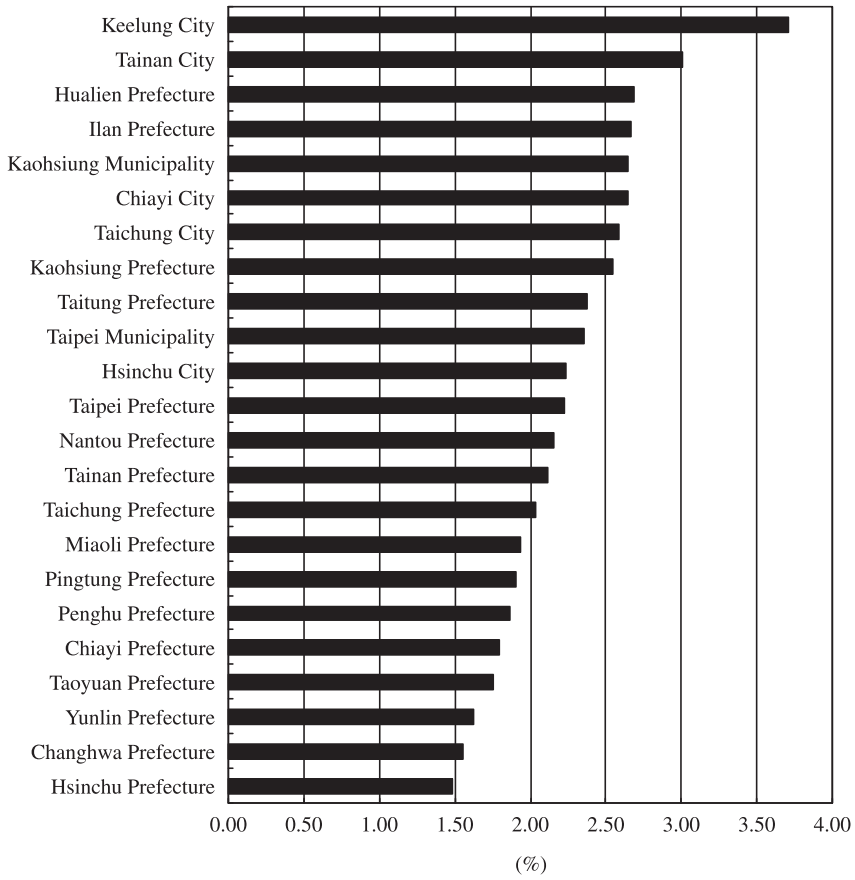
[1] According to the statistics from Taiwan's National Policy Agency, the criminal rate before 1995 was below 15,000 cases per million people, but it then surged to an average of 20,532 cases per million people from 1995 to 2003. Data from the Department of Health shows that the suicide rate in Taiwan has doubled within the past five years. Increases in the suicide rate and criminal activities have been identified to be connected to the increase of the unemployment rate. Bluestone and Harrison (1982) find that every 1 percent increase in U.S. unemployment is associated statistically with 37,000 more deaths, among them 920 more people commit suicide and 650 commit homicide.

[2] The evident declining trend of deviation of Taiwan's regional unemployment rates after 2000 was mainly due to the significant economic downturn for the whole economy after 2000 so that the unemployment rate increased simultaneously for all the 23 regions and thus reduced the deviation of unemployment rates among regions. However, from Table 1 the correlation coefficients for regional unemployment rates between 2000 and 2004 remains as high as 0.58 confirming the persistency strength.

TABLE 1. CORRELATIONS OF TAIWAN'S REGIONAL UNEMPLOYMENT RATES OVER TIME

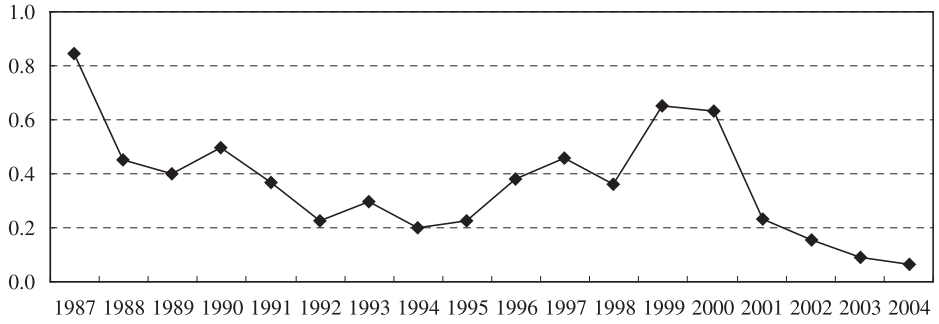
Year	1987	1990	1995	2000
1990	0.83			
1995	0.65	0.67		
2000	0.44	0.52	0.66	
2004	0.08	0.27	0.51	0.58

FIG 1. AVERAGE ANNUAL UNEMPLOYMENT RATE FOR TAIWAN'S 23 REGIONS: 1987-2004



studies in the literature. Evans and McCormick (1994) find evidence of persistent deviations among regions in Britain in the 1970s and 1980s. Neumann and Topel (1991) also find that from the early 1950s to the early 1980s the unemployment rate tended to persist among states in the U.S. Partridge and Rickman (1997) also discover evidence in the 1970s and early 1990s of a significant deviation of unemployment rates that exist across states in the U.S. Feasel and Rodini (2002) find from 1985 to 1997 that the unemployment rates among 57 counties in California also demonstrate a significant trend of persistent deviations. In other words, persistent deviation among regional unemployment seems to be a common world-wide phenomenon.[3]

FIG 2. DEVIATION OF UNEMPLOYMENT RATE AMONG TAIWAN'S 23 REGIONS



The aim of the paper is to analyze the sources of persistent deviations of the regional unemployment rates in Taiwan. This paper uses 1995-2004 panel data of Taiwan's 23 regions to examine and test factors that may cause the persistent discrepancies in the regional unemployment rates in Taiwan. The paper is organized as follows: Section 2 lays out the empirical model and discusses the expected sign for the explanatory variables. Section 3 states the estimation method and related econometric techniques. Section 4 contains data description and analysis. Estimation results are shown in Section 5. Concluding remarks are in Section 6.

II. *The Empirical Model*

According to neoclassical theory, mobility between workers and firms will result in market equilibrium with an equal wage and unemployment rate across regions. However, due to different development stages and characteristics of the regions, it may end up that regions have different long-run unemployment rates. In the literature, factors that cause the discrepancies in the unemployment rate across regions include compensating differentials for amenities and opportunities of employment, see, e.g., Hall (1972), Marston (1985), and Greenwood and Hercowitz (1991); increasing costs of migration arising from community identity or social networks, see, e.g., Partridge and Rickman (1997b); demographic composition such as age, gender, education, and family background, see, e.g., Feasel and Rodini (2002); and industry composition and labor mobility, see, e.g., Partridge and Rickman (1995, 1997b), Topel (1986), and Gabriel *et al.* (1993). Marston (1985) asserts factors due to the cost of migration as being disequilibrium factors while that due to heterogeneous labor preference such as compensating differentials are as equilibrium factors. Overall, the macro environment is potentially an underlying common factor that affects the unemployment rate across regions. Therefore, our empirical model is specified as follows:

$$U_{it}=\mu_{it}+\beta_1 DEMO_{it}+\beta_2 INDU_{it}+\beta_3 COMP_{it}+\beta_4 MOBI_{it}+\beta_5 MACO_{t}+\varepsilon_{it} \qquad (1)$$

$$E(\varepsilon_{it}|X_{it})=0 \text{ and } Var(\varepsilon_{it}|X_{it})=\sigma_{\varepsilon}^2, \ \forall i=i' \text{ and } t=t',$$

[3] OECD (1988) points out that between 1975 and 1987 countries such as the UK, Japan, and Italy endured a significantly high correlation among their regional unemployment rates.

where index *i* stands for region and *t* denotes time, DEMO are variables for demographic composition, INDU are variables for industrial structure, COMP are variables due to compensating for the differentials argument, MOBI are variables for labor mobility and proxies for costs of migration, and MACO are variables controlling for the macro environment.

Demographic composition includes population, education, and family background variables. In general, the larger the proportion is of young workers in the labor market, the higher the unemployment rate will be as young workers tend to search intensively and change jobs more often.[4] The greater the proportion of workers having a higher educational attainment, the lower the unemployment rate will be as more educated workers are more adaptive to the rapid changing economy. However, more skill-oriented or complex jobs usually encounter problems of asymmetric information between workers and firms which may cause a longer searching or matching process and thus increase the unemployment rate. Hence, the net effect of more educated workers on the unemployment rate is ambiguous. We use the share of labor force by age and education attainment to represent the demographical composition.

As for the family characteristics, male workers usually bear the major responsibility for their families and also tend to choose and consider jobs from a career development perspective. Hence, they are more motivated and active in finding a job or more reluctant to quit a job. Thus, the higher the percentage of males in the regional labor force, the lower the regional unemployment rate will be. By the same token, the higher the dependent ratio is in the family which imposes a heavy burden and responsibility on the workers of the family, the lower the unemployment rate will be. As women tend to leave the labor market after they get married, regions with a larger share of married women also tend to have a higher unemployment rate. We use the percentage of males in the labor force, the population share of married women, and dependence ratio of the family in a region to proxy for the family characteristics.

Lilien (1982) points out that the shift of industrial composition affects not only the unemployment rate at the macro level, but also the industry mix and labor demand at the regional level. Therefore, industry composition affects regional unemployment rates. The more capital-intensive an industry is, the higher the unemployment rate will be as capital may substitute for labor. Hence, the manufacturing industry tends to have a higher unemployment rate than the agriculture industry or services industry. Furthermore, different industries require different skills which generate various degrees of searching and matching in the labor market, and thus different compositions of industrial structure will end up with different unemployment rates. We include the employment share of various industries to measure the industrial composition of a region.

According to the compensating differentials argument, Hall (1972) and Topel (1986) claim a positive hedonic wage level-unemployment trade-off. Workers also care about the region's characteristics, which include amenities and quality of living; better amenities are usually compensated with a higher unemployment rate. People living in a better quality community are more tolerable to a higher unemployment rate. We add variables of real wage per worker of the region and the land share of parks and green land in the total region to test for the

[4] Topel and Ward (1992) find that a typical American on average will change seven full time jobs for the first ten years when he/she enters the labor market. Lin (2000) finds from 1996 to 1998 that college graduates entering the labor market on average change 1.22 jobs for the first year, with 39% not changing jobs, 29% change one job, 19% change two jobs, 10% change 3 jobs, 3% change 4 jobs, 1% change more than 5 jobs.

compensating differentials hypothesis. As in Blackaby and Manning (1992) and Partridge and Rickman (1997b), we also include growth in real wages of the region to control for offsetting disequilibrium factors so as to help identify local labor market shocks, which may be demand or supply driven.

As for labor mobility, factors like community identity and social networks affect the cost of migration and thus workers' mobility. Strong community identification and cohesive social networks increase the cost of migration; hence, they are usually compatible with higher unemployment. We include a house ownership variable to stand for the worker's community identity and social networks which can be an index for the costs of migration. Thus, the higher the ratio of house ownership in the region, the higher the cost of migration will be and hence the greater the unemployment rate will be for the region. Furthermore, job opportunities affect the probability of finding a job and/or leaving unemployment status, and thus influence the unemployment rate. We use the inflow and outflow of regional migration as proxies for the opportunities to find jobs. To catch the social externality and potential well-being of the region, we further include a measure of a region's population density to control for the degree of urbanization, which has often been interpreted as a measure of positive externalities from an agglomeration of the economic activities.

Some macro aggregate variables are additionally included to control for the macro environment. Since Taiwan is a small open economy, its aggregate economic performance strongly influences the labor demand of the local regions, and its increasing investment in foreign countries due to a surge in domestic labor costs and outsourcing of traditional industries has become a prominent phenomenon since the 1990s. From 1990 to 2000, the real wage in Taiwan has grown at an average annual growth rate of 2.7%. From 1952 to 1990, Taiwan's cumulative approved outward foreign direct investment was only US$3.08 billion, but the amount of approved FDI increased tremendously after 1990, from US$2.80 billion in 1993 to US$10.32 billion in 2004, among which about 67.24% invested in China. Hence, our macro variables include the annual GDP growth rate of the economy, foreign direct investment, and the share of FDI in China.

III. *The Estimation Method*

1. Fixed vs. Random Effect Model

We adopt panel data analysis for the cross-region data to allow for controlling the region-specific attributes. The one factor fixed or random effects model may be estimated with an autocorrelated error structure. In equation (1), if μ_{it} is a separate constant term for every region (regional fixed effect), then the disembodied factor $\mu_{it}=\mu_i$. Thus, this fixed effect model is written as:

$$U_{it}=\mu_i+\beta_1 DEMO_{it}+\beta_2 INDU_{it}+\beta_3 COMP_{it}+\beta_4 MOBI_{it}+\beta_5 MACO_t+\varepsilon_{it} \quad (2)$$

If $\mu_{it}$is an individual specific disturbance, then the disembodied factor $\mu_{it}=\bar{\mu}+v_i$. This random effect model is written as:

$$U_{it}=\bar{\mu}+\beta_1 DEMO_{it}+\beta_2 INDU_{it}+\beta_3 COMP_{it}+\beta_4 MOBI_{it}+\beta_5 MACO_t+v_i+\varepsilon_{it} \quad (3)$$

where $v_i \sim iid(0, \sigma_v^2)$ and $Cov(\varepsilon_{it}, v_i)=0$. The random effect model is a generalized regression model and all disturbances have variance $Var(\varepsilon_{it}+v_i)=\sigma^2=\sigma_\varepsilon^2+\sigma_v^2$.

If the explained variables correlate with v_i, then v_i will not satisfy the presumed condition. The estimated parameters of the random effect model will produce error. On the contrary, if v_i satisfies the condition, using the random effect model will be more efficient than using the fixed effect model.[5]

To verify the appropriate model, the Hausman (1978) test for random effect model or fixed effect model is used. The null hypothesis is

H_0 : $v_i$does not correlate with explained variables

$$H=(b_{fix}-b_{ran})'(M_{fix}-M_{ran})^{-1}(b_{fix}-b_{ran})\sim \chi^2$$

Where b_{fix} and b_{ran} are respectively the estimated parameters of the fixed effect model and random effect model, M_{fix} and M_{ran} are the corresponding covariance matrices.

2. Autocorrelation

Assume that labor markets being in equilibrium in all regions, but are disturbed by a shock which redistributes labor demand. As a result of the shock, disequilibrium exists in the short run and the unemployment rate and the wage must change to regain a new equilibrium. Depending on the adjustment process, in general, some fraction of the last period's disequilibrium will persist into the present. Thus, the one factor fixed and random effects model may be estimated with an autocorrelated error structure. In any case, as the unemployment rates at different periods may be correlated, this renders a series correlation among the disturbance terms, i.e.

$$\varepsilon_{it}=\rho\varepsilon_{it-1}+\phi_{it},$$

where ϕ is an independent disturbance term, ρ is the first-order series correlation coefficient measuring the residual impact from the last period to the current period, and (1-ρ) is the fraction of the disequilibrium that is eliminated by mobility between the regions during one period. If this happens, then an AR1 corrected panel data analysis will be used in the estimation.[6]

The AR1 model for the fixed and random effects specifications is estimated by two step GLS. The estimator is

$\rho=\dfrac{\sum_{i=1}^{N}\sum_{t=2}^{T_i}e_{it}e_{i,t-1}/\left[\sum_{i=1}^{N}(T_i-1)\right]}{\sum_{i=1}^{N}\sum_{t=2}^{T_i}e_{it}^2/\left[\sum_{i=1}^{N}(T_i-1)-K\right]}$, where N is the number of groups, K is the number of regressors, T is the number of observations, and $e_{it}=(U_{it}-\bar{U}_i)-\hat{\beta}'(X_{it}-\bar{X}_i)$ with X_{it} includes all regressors that we used in this paper.

3. Endogeneity Test

Econometric models usually assume that independent variables and error term are not correlated to each other, and thus it is easier to infer estimation and testing results. However, if

[5] See Mundlak (1978) for a detailed discussion.

[6] For the detailed discussion of the appropriate properties of panel data analysis, see, for example, Marston (1985) and Hsiao, Hashe, and Kamil (2002).

the hypothesis is not true, then an endogenous bias will occur. In this paper, the average wage rate (average wage growth rate) and the migration variables are likely to correlate with the regional unemployment rate. If so, the wage and the migration variables are endogenous variables and the endogeneity bias will arise.

The Durbin-Wu-Hausman endogeneity test procedure, as an omitted variable test with appropriately constructed instrumental variables, is adopted for the endogeneity test.[7] The validity of instruments needs to satisfy both instrument relevance and instrument exogeneity conditions. The F-test is adopted for the test of explanatory power of the instrumental variable and over-identifying restrictions test is used for instrument exogeneity.[8] The null hypothesis of DWH test is that the potential endogeneity of the variable does not bias the estimated coefficients.

IV. *Data Description and Analysis*

The data used in this paper pertaining to the 1995 to 2004 period are from various official sources. Table 2 presents all the variables' definitions and sources used in the paper. Table 3 presents the variables' related basic summary statistics.

From Table 3 we find a large variation in the demographic composition among Taiwan's 23 regions of cities and prefectures. Hsinchu City has the largest proportion of the youth population with 17.57%, while Chiayi Prefecture has the lowest at 6.08%; Chiayi Prefecture has the largest proportion of the senior citizen population with 22.77%, while Taichung City has the lowest at 4.27%. In terms of education, Taipei Municipality has the largest proportion of population with a university educational attainment of 55.51%, and Miaoli Prefecture has the lowest value of only 7.54%; the highest proportion of educational attainment below primary school is Yunlin Prefecture at 48.83%, while the lowest is Taipei Municipality of 4.53%. For the whole Taiwan area, the ratio of married women is 57.44%, among which Hsinchu Prefecture has the highest of 63.3% and Taitung Prefecture has the lowest of 50.4%. The dependent ratio is the highest for Hsinchu Prefecture at 52% and lowest is for Taipei Prefecture of 34.91%. The proportion of males in the labor force is highest in Penghu Prefecture at 70% and lowest in Taipei Municipality at 52.76%.

As for the industrial structure, in terms of employed workers, on average, the service sector is 49.68%, followed by the industry sector at 36.43%, and the agriculture sector, which is lowest at 13.89%. Among the regions, Taipei Municipality has the highest ratio of employed workers in services at 82.09% while Chiayi Prefecture is the lowest at 26.02%; Hsinchu Prefecture has the highest ratio of employed workers in industry at 59.45% and Penghu Prefecture has the lowest at 11.8%; Yunlin Prefecture has the largest share in agriculture at 45.76% and Taipei Municipality has the lowest at only 0.17%. Average workers' real annual wage (measured by constant price in 2001) is NT$268,496, among which Taipei Municipality is the highest at NT$478,926 and Chiayi Prefecture is the lowest at NT$141,583, a deviation of more than three-fold. However, the average annual wage growth rate is 0.16, with the highest at

[7] The Durbin-Wu-Hausman (DWH) test which was first proposed by Durbin (1954), Wu (1973), and Hausman (1978).

[8] See, for example, Stock and Watson (2007) for a detailed discussion of the test procedure.

TABLE 2. DEFUBUTION AND SOURCES OF THE VARIABLES

Variable	Definition	Source
UNEMP	The ratio of the unemployed to the labor force (%)	[3]
Age:		
YOUNG	The share of labor force aged 15 to 24 (%)	[3]
OLD	The share of labor force aged above 55 (%)	[3]
Education:		
LEDU	The share of population aged over 15 with a primary education or less (%)	[3]
HEDU	The share of population aged over 15 with a higher education or above (%)	[3]
Family:		
MALE	The percentage of the labor force that is male (%)	[5]
MARRY	The population share of married women aged over 15 (%)	[5]
DEPEND	The ratio of population aged under 14 or over 65 to the population of those aged between 15 to 64 (%)	[3]
Industry:		
AGRI	The share of employed workers engaged in agricultural, forestry, fishery, and hunting industries (%)	[1]
MANU	The share of employed workers engaged in the manufacturing industry (%)	[1]
CONS	The share of employed workers engaged in the construction industry (%)	[1]
WHOL	The share of employed workers engaged in wholesale and restaurant service (%)	[1]
TRAN	The share of employed workers engaged in transportation and storage industry (%)	[1]
FINA	The share of employed workers engaged in financial and insurance industry (%)	[1]
BUSI	The share of employed workers engaged in business services (%)	[1]
SOCI	The share of employed workers engaged in social services (%)	[1]
Environment:		
DENS	Population density in urban areas of the region (hundred person per square kilometer)	[4]
AMEN	The average square measure of parks and green land per person (square meters per person)	[4]
Wage		
WAGE	The real annual wage per worker in the region (NTD$10,000) (Base=2001)	[2]
GWAGE	Average annual wage growth rate in the region (%)	[2]
Mobility：		
HOME	The ratio of house ownership (%)	[2]
INMI	People moved in as a share of the region's population (%)	[4]
OUTMI	People moved out as a share of total population (%)	[4]
Macro-Variable:		
GROW	Average annual growth rate of GDP in Taiwan (%)	[6]
ODFI	Taiwan's total outward foreign direct investment (USD$ hundred million)	[7]
CHINA	Share of Taiwan's outward foreign direct investment in China (%)	[7]

Sources: [1] Report on the Manpower Utilization Survey in Taiwan Area, R.O.C.;
[2] Report on the Survey of Family Income and Expenditure in Taiwan, R.O.C.;
[3] Yearbook of Manpower Survey Statistics, Taiwan Area, R.O.C.;
[4] Statistical Yearbook of Interior of the Republic of China;
[5] Taiwan-Fukien Demographic Fact Book, R.O.C;
[6] Statistical Abstract of National Income in the Taiwan Area, R.O.C.;
[7] The Investment Commission, Ministry of Economic Affairs, R.O.C.

TABLE 3. SUMMARY STATISTICS OF THE VARIABLES

Variable	Mean	Stan. Dev.	Max	Min
UNEMP	3.47	1.25	5.51	1.02
Age				
YOUNG	11.48	2.39	17.57	6.08
OLD	11.15	4.68	22.77	4.27
Education				
LEDU	23.40	10.03	48.83	4.53
HEDU	21.80	9.87	55.51	7.54
Family				
MALE	60.79	3.16	70.00	52.76
MARRY	57.44	2.61	63.30	50.40
DEPEND	44.40	3.34	52.00	34.91
Industry				
AGRI	13.89	12.99	45.76	0.17
MANU	26.07	13.40	51.00	1.37
CONS	10.36	2.65	25.60	5.12
WHOL	22.79	7.00	39.75	10.41
TRAN	4.96	3.95	24.78	1.34
FINA	3.51	2.19	12.25	0.68
BUSI	2.12	1.67	9.56	0.00
SOCI	16.30	4.27	32.17	8.59
Environment				
DENS	42.06	22.18	103.06	13.08
AMEN	6.553	3.3759	18.76	1.33
Wage				
WAGE	31.93	2.86	40.87	26.49
GWAGE	0.16	3.74	16.63	−10.18
Mobility				
HOME	86.64	5.14	95.94	71.70
INMI	3.48	1.10	7.33	1.30
OUTMI	3.65	0.91	7.03	1.80
Macro-Variable				
GROW	4.70	2.51	6.59	−2.17
ODFI	70.86	30.50	116.67	24.50
CHINA	48.22	15.02	69.61	27.71

Note: See Table 2 for variable definition and sources.

16.63% in Yunlin Prefecture and the lowest of -10.18% in Chiayi City.

In terms of migration, on average the rate of in-migration is 3.58% and that of out-migration is 3.65%. Taichung City has the highest in-migration of 7.33% and Penghu Prefecture has the highest out-migration rates of 7.03%. However, Changhwa Prefecture has both the lowest in-migration and out-migration rates of 1.38% and 1.80%, respectively. The average house ownership in Taiwan is as high as 86.64%, among which Hsinchu Prefecture has the highest of 95.94% and Pingtung Prefecture has the lowest of 71.70%.

As for the population density, an index for urbanization, the average figure is 4,206 people per square kilometer. Kaohsiung Municipality has the highest population density of 10,306 people per square kilometer and Chiayi Prefecture has the lowest of only 1,308 people per square kilometer. The area of parks and green land per person, a proxy for amenity, amounts to the average figure of 6.55 square meters per person. Hualien Prefecture has the largest area of

18.76 square meters per person and Yunlin Prefecture has the smallest area of 1.33 square meters per person.

Overall, there are large discrepancies in demographic composition, industry structure, income level, urbanization, and migration among Taiwan's 23 regions.

V. *Estimation Results*

Table 4 presents the regression results for Taiwan's regional unemployment rates. For the demographic variables, the share of the youth population has a positive effect, implying regions with more less-experienced workers or young workers (who usually shop around and take time to find a better job-match) tend to have a higher unemployment rate. However, the share of the senior citizen population has a negative effect which reduces the regional unemployment rate, since senior citizens tend to be experienced workers who are less likely to be laid off by firms during temporary economic recession. The ratio of the population over age 15 having a higher education or primary education has a positive effect, implying that labor market is in favor of workers with high school education. The reasons that workers with a high school education find it relatively easier to find a job are from both demand and supply sides. On the supply side, the rapid expansion of higher education institutions since 1990 has provided an oversupply of higher education workers. The number of colleges and universities in Taiwan had increased from 46 in 1990 to 127 in 2000. On the demand side, the intermediate technology or skill is the most required skill in production in Taiwan. According to Statistics of Exports and Imports, goods with a middle degree of technology intensity have the largest share of 50% in total exports, followed by goods with a high degree of technology intensity 30% and that of a low degree of technology intensity 20%. From export structure it is clear that production technology in Taiwan requires more demand for middle-skilled workers than for high-skilled or less-skilled workers.

However, the effects of age structure and lower educational attainment become insignificant after controlling for variables of the macro environment. This may be because macro variables represent some underlining changes for the demand of different labor skills, especially outward foreign direct investment and investment share in China which affect the demand for the less experienced and less educated worker, thus dominating the effects generated by either age structure or lower educational attainment.

As for the family characteristics, the share of males in the labor force and the ratio of dependents both have negative effects on the unemployment rate, where the former is significant and the latter is insignificant. In a Chinese culture, the male has the pressure to get married and to have descendants to carry on the family name. It is also true that males used to take job selection more seriously as a career than females who may likely withdraw from the labor market after they get married. By having a nuclear family or a family including children and elders, a worker will bear more burden and responsibility and be more aggressive in finding a job or willing to accept a job even if it underpays. This result may also imply why in an oriental society a larger family size usually has a lower unemployment rate than that in a western society, which tends to have a smaller family size. The share of married women has a positive and significant effect which implies that married women have the option to stay at home doing housework instead of working outside the home, while single women have to find

a job to support themselves, hence reducing the unemployment rate. For those employed female workers, if they leave labor market after they got married, the unemployment rate should increase. Thus, family factors play an important role in explaining regional unemployment rates.

For variables of industrial structure, compared to the reference group of agriculture, only construction, wholesale and social service industries have a positive and significant effect on regional unemployment. Construction and wholesale jobs are usually lower-skilled oriented and also tend to have a higher labor turnover rate which results in a higher unemployment rate. According to Taiwan's Manpower Survey data, Taiwan's economy has grown more service-oriented since the late 1980s. However, the wholesale industry, which is the largest industry in the service sector with an increasing employment share that reached 41% in 2001, has the highest unemployment rate in the service sector. By asking the unemployed who previously worked in the wholesale industry, the survey shows that the two key reasons for being unemployed are not being satisfied with the job (around 50%) and because the establishment closed or the business shrunk (around 35%). Thus, high job and firm turnover rates have caused the wholesale industry to inherit a high unemployment rate. The manufacturing industry usually is more capital-oriented than other industries, hence requiring more coordination among different skill levels during the production process or substituting capital for labor and thus generating a potentially higher unemployment rate. The effect of the manufacturing industry is positive, but insignificant.

The average real wage per worker has a negative and significant effect. This result is in contrast to the theory of compensating wage differentials whereby high wages compensate higher unemployment, but it is consistent with the demand spillover hypothesis that high-wage industries may generate larger multiplier effects on labor demand as claimed by Patridge and Rickman (1997). This result is also consistent with the efficient wage theory that higher wages signal higher worker productivity and more able workers tend to find a job more easily and also are less likely to be laid off by the firms. Lerman and Skidmore (1999) also find that low-wage workers tend to have more job turnover and periods without work than those with good jobs in U.S. However, the growth of real wages has a positive, but insignificant effect, implying that labor supply shocks are likely more important than labor demand shocks.

The coefficient of the land share of parks and green land, a proxy for local amenities, is positive, but insignificant.[9] The positive effect is consistent with the compensating differentials argument that better amenities compensate for a higher unemployment rate. The coefficient of population density is negative, but insignificant, implying a matching problem between employers and employees may be mitigated in an urban area, because there is plenty of opportunities and job diversification which reduce unemployment.[10]

As for labor migration, as is consistent with the literature, the variable of owner-occupied house has a significantly positive effect, implying that the increase of migration cost due to community identity or social networks forms a barrier to labor mobility and thus increases the

[9] We also try other proxies for amenities which include schools, supermarkets, and infrastructure. The results, however, remain positive, but insignificant.

[10] We also try other urbanization variables such as land share of an urban area, the land share of the business district of an urban area, and physicians per hundred people. The effects of these proxies are similar as in the case of population density.

unemployment rate. It may also imply a wealth effect in that better financial conditions enable the worker to be able to bear a longer duration of unemployment. In-migration has a negative, but insignificant effect, while out-migration has a positive and significant effect. This result suggests that a lower opportunity to find a job leads to a greater out-migration of the employed with respect to the unemployed of the region and thus increases the regional unemployment rate.

However, the wage rate may be correlated with the regional unemployment rate as wage rates and unemployment rates are likely determined simultaneously, and the migration variables are also likely to correlate with the regional unemployment rate as the causality may run the other way from the regional unemployment rate to migration across regions. In those cases, the average wage rate, average wage growth rate, and migration variables are endogenous. To test for the endogeneity of the average wage rate, average wage growth rate, and migration variables, the Durbin-Wu-Hausman test is conducted.[11] The null hypothesis is that the potential endogeneity of the variable does not bias the estimated coefficients. The results of the DWH test are shown on the bottom of Table 4 which show insignificancy i.e. they cannot reject the null hypothesis for wage and migration variables respectively, suggesting that the endogeneity problem is negligible.

As for the aggregate variables to control for the macro environment, all three macro variables show significant effects, implying that the macro environment is an important common factor explaining the unemployment rates across regions. As we used regional data of 23 cities and prefectures, each region is considered small enough that it has no direct effect on macro variables, which is then treated as exogenous variables. Both current and lagged economic growth rates have negative and significant effects, which are consistent with Okun's law that persistent economic growth is beneficial to the reduction of the unemployment rate. The variable of outward foreign direct investment has a positive and significant effect, implying that outward foreign investment does generate a de-industrialization effect which reduces the demand for the local labor market. Moreover, the share of outward foreign direct investment in Mainland China also has a positive and significant effect implying that the more Taiwan's outward foreign investment in China the higher the regional unemployment rate will be. Since 1995, for national security reasons the Taiwanese government has adopted a "No haste and be patient" restricted trade and investment policy toward China which hinders a possible vertical integration between industries across the Taiwan Strait under free trade.[12] As a result, a great deal of foreign investment moves to China either under the table or through a third country which not only prohibits vertical integration across the Strait but also accelerates the process of de-industrialization.

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[11] The endogenous variables are average wage rate (average wage growth rate) and migration variables. In constructing the first stage of the instrumental variable regression, for the average wage rates (average wage growth rate) the instrumental variables are the number of automobiles per hundred households, tax burden per capita, and employer-to-employee ratio; for the migration variables the instrumental variables are educational expenditure per student, population per doctor, and housing rent. As for the validity of instruments, our instruments satisfied F test for the relevance condition and passed over-identification test for the exogeneity condition, see Table 4 for the relevant statistics. The results of first stage regressions are not reported here but upon request to the authors.

[12] By surveying Taiwanese firms invested in China, Gau *et al.* (1995) find that 55.7% of firms engage in vertical integration by producing parts in their Chinese subsidiaries and assembling final products in the Taiwanese host company.

TABLE 4. ESTIMATION RESULTS OF PANEL DATA ANALYSIS OF TAIWAN'S 23 REGIONS

	Panel data without Macro-Variables			Panel data with Macro-Variables		
Indep. Var.	OLS	Panel	Panel AR(1)	OLS	Panel	Panel AR(1)
Age						
YOUNG	0.201***	0.192**	0.244***	−0.069	0.086	0.110
	(0.076)	(0.090)	(0.096)	(0.053)	(0.065)	(0.077)
OLD	−0.034	−0.264***	−0.407***	−0.001	−0.76	−0.162**
	(0.058)	(0.084)	(0.091)	(0.040)	(0.059)	(0.072)
Education						
LEDU	0.063**	0.055	0.160**	0.023	0.054	0.095*
	(0.031)	(0.058)	(0.064)	(0.024)	(0.046)	(0.050)
HEDU	0.008	0.130**	0.206***	0.009	0.086**	0.108**
	(0.028)	(0.050)	(0.054)	(0.020)	(0.041)	(0.045)
Family						
MALE	−0.036	−0.058*	−0.017	−0.031*	−0.014	−0.024
	(0.022)	(0.033)	(0.033)	(0.017)	(0.022)	(0.023)
MARRY	0.221***	0.128**	0.054	0.063**	0.110**	0.024
	(0.045)	(0.063)	(0.079)	(0.034)	(0.055)	(0.058)
DEPEND	−0.020	−0.047	−0.018	−0.046**	−0.049	−0.021
	(0.026)	(0.052)	(0.056)	(0.019)	(0.037)	(0.045)
Industry						
MANU	0.003	0.006	0.005	0.001	0.010	0.001
	(0.010)	(0.017)	(0.018)	(0.006)	(0.012)	(0.013)
CONS	0.054**	0.051*	0.048*	0.006	0.015	0.024
	(0.023)	(0.028)	(0.029)	(0.016)	(0.020)	(0.020)
WHOL	0.034**	0.033*	0.019	0.008	0.006	0.003
	(0.017)	(0.017)	(0.023)	(0.012)	(0.013)	(0.015)
TRAN	0.032*	0.034	0.042	0.051***	0.041	0.029
	(0.017)	(0.041)	(0.041)	(0.012)	(0.029)	(0.028)
FINA	0.041	0.021	0.013	0.017	0.001	0.006
	(0.052)	(0.052)	(0.053)	(0.035)	(0.036)	(0.036)
BUSI	−0.019	−0.042	−0.052	−0.003	−0.040	−0.060
	(0.063)	(0.066)	(0.065)	(0.044)	(0.047)	(0.045)
SOCI	−0.043**	−0.044**	−0.043*	−0.000	−0.011	−0.013
	(0.021)	(0.022)	(0.022)	(0.015)	(0.019)	(0.018)
Environment						
DENS	−0.008**	−0.023*	−0.024**	−0.001	−0.008	−0.007
	(0.004)	(0.012)	(0.012)	(0.003)	(0.008)	(0.008)
AMEN	−0.017	−0.019	0.007	0.001	−0.004	−0.003
	(0.019)	(0.034)	(0.009)	(0.006)	(0.006)	(0.006)
Wage						
WAGE	−0.212***	−0.145***	−0.119**	−0.164***	−0.122***	−0.102***
	(0.037)	(0.048)	(0.050)	(0.025)	(0.035)	(0.036)
GWAGE	0.006	−0.003	−0.002	0.018**	0.010	0.011
	(0.013)	(0.012)	(0.012)	(0.009)	(0.009)	(0.008)
Mobility						
HOME	0.046***	0.048***	0.040***	0.008	0.022**	0.021**
	(0.016)	(0.015)	(0.016)	(0.011)	(0.011)	(0.010)
INMI	−0.110	−0.031	−0.018	−0.172*	−0.138	−0.147
	(0.130)	(0.128)	(0.129)	(0.091)	(0.091)	(0.082)
INLAG	−0.079	−0.193*	−0.217*	−0.199**	−0.137	−0.147
	(0.143)	(0.116)	(0.113)	(0.099)	(0.099)	(0.099)
OUTMI	0.291**	0.297**	0.265*	0.325***	0.328**	0.155
	(0.127)	(0.130)	(0.134)	(0.110)	(0.125)	(0.093)
OUTLAG	0.130	0.140*	0.190*	0.085	0.105	0.001
	(0.117)	(0.103)	(0.115)	(0.082)	(0.088)	(0.083)
Macro-Variable						
GROW				−0.172***	−0.157***	−0.156***
				(0.014)	(0.013)	(0.011)

	Panel data without Macro-Variables			Panel data with Macro-Variables		
Indep. Var.	OLS	Panel	Panel AR(1)	OLS	Panel	Panel AR(1)
LGROW				−0.134***	−0.124***	−0.111***
				(0.016)	(0.015)	(0.014)
ODFI				0.014**	0.011**	0.010**
				(0.005)	(0.005)	(0.004)
CHINA				0.021***	0.017***	0.014***
				(0.003)	(0.003)	(0.003)
Constant	27.329***	23.202***	19.391***	18.515***	9.605***	11.541***
	(3.059)	(5.241)	(5.388)	(3.065)	(3.257)	(3.993)
F test for Macro Var.				58.39***	44.48***	42.92***
Fixed vs.Random model		−0.9	−0.17		−0.7	−0.11
Validity test for Instrument of In-Migration						
F test (First stage)	34.71***	34.71***	34.71***	34.71***	34.71***	34.71***
Over-identification test	7.20	6.42	6.21	5.52	5.01	4.44
Endogeneity(DWH) test	1.31	1.20	0.88	1.53	1.03	0.43
Validity test for Instrument of Out-Migration						
F test (First stage)	42.62***	42.62***	42.62***	42.62***	42.62***	42.62***
Over-identification test	7.20	6.42	6.21	5.52	5.01	4.44
Endogeneity(DWH) test	−1.24	−1.43	−0.92	−1.12	−0.97	−0.78
Validity Test for Instrument of Wage						
F test (First stage)	9.53***	9.53***	9.53***	9.53***	9.53***	9.53***
Over-identification test	6.78	5.40	4.22	4.17	3.81	2.31
Endogeneity(DWH) test	1.55	1.32	0.85	2.05	1.82	1.14
			ρ=0.2517			ρ=0.2455
Adj R^2	0.728	0.805	0.795	0.875	0.905	0.858
X-variables effect		0.712	0.618		0.897	0.857
		84.26%	76.2%		94.82%	92.85%
Regional variables					79.38%	72.11%
Macro-variables					20.62%	27.89%
Regional-specific effect		0.133	0.193		0.049	0.066
		15.74%	24.80%		5.18%	7.15%

Notes: 1. Agriculture is the reference group for the industrial structure. INLAG and OUTlAG are lag variables of in-migration and out-migration, respectively. LGROW is the lag variable for the economic growth rate.

2. Figures in the parenthesis are standard deviation. *, **, and *** stand for significance at 10%, 5%, and 1% levels, respectively.

3. The F test for all macro variables is under the null hypothesis that all the coefficients of macro variables are zero.

4. The null hypothesis of the Hausman test for Fixed vs. random model is that random model is appropriate.

5. In the first stage regression, instrumental variables for average wage rate (average wage growth rate) are the number of automobiles per hundred households, tax burden per capita, and employer-to-employee ratio; the instrumental variables for migration variables are educational expenditure per student, population per doctor, and housing rent. The F test is for the instrument relevance condition (the significance of coefficients of all the instrumental variables). A rule of thumb is that F statistics should be grater than 10 and any values below 10 implies that the selected instrumental variables have insignificant explanatory power and thus generates estimation bias.

6. The null hypothesis of over-identification test is that all the including instrumental variables are jointly exogenous.

7. The Durbin-Wu-Hausman test is for the endogeneity test of the wage rate (wage growth rate) and migration variables under the null hypothesis that the potential endogeneity of the variable does not bias the estimated coefficients.

A joint F test for the macro variables goes significantly against the null hypothesis that macro variables have no effect on regional unemployment rates. The partial correlation coefficient for the macro variables is 0.56, which implies that over 50% of unexplained residuals in the regression excluding the macro variables are explained by those macro variables. Thus, the macro environment does significantly affect the regional labor markets.

The panel study of Taiwan's 23 regions shows that the model specifications have a range of adjusted R^2 of 0.72～0.90, and our economic variables have an explanatory effect of 61～90 % and the regional-specific effect is only 7～14 %. This implies that our model to a certain degree has captured the common factors in explaining regional deviations in the unemployment rate. The estimated coefficient of autocorrelation, ρ, with or without macro variables being included in the model is about 0.25, implying the residual impact from the previous period is relatively weak on the current period unemployment rate after controlling for the explanatory variables. The Hausman test for fixed vs. random model cannot reject the null hypothesis, implying that the random effect model is more appropriate. These results confirm that our model specification can well explain the evolution of regional unemployment rates. Aside from the macro environment which explains about one quarter, these common regional characteristic factors, which explain about three quarters, include family structure, labor composition, educational attainment, age structure, industrial structure, population density, and migration cost.

VI. *Concluding Remarks*

Using Taiwan's 23 regions' panel data pertaining to the 1995-2004 period, this paper uses equilibrium and disequilibrium factors to analyze the deviations in regional unemployment rates. The main findings of the paper are: (i) There exists a persistent deviation among Taiwan's regional unemployment rates. Regions with a higher (lower) unemployment rate tend to have a higher (lower) unemployment rate in the future. (ii) The effect of economic variables is greater than the regional-specific effect, as the former explains 76～95 % and the latter only 5～24 %. Moreover, within the economic variables the aggregate macro variables explain about one quarter and the regional-related characteristic variables explain about three quarters. (iii) Family characteristics, labor composition, industrial structure, population density and migration cost have a significant effect on the regional unemployment rate. In summary, regions with a large share of youth or less experienced labor structure, a small share of senior citizens or more experienced labor structure, a small share of males in the labor force or a large share of married women, a higher own-occupied house ratio, a lower population density, a higher out-migration rate or a lower in-migration rate, and a more construction, wholesale, and manufacturing-oriented industry structure tend to have higher unemployment rates. (iv) The macro environment is an underlying common source that strongly affects the local labor market and hence the unemployment rate across regions. Persistent economic growth stimulates the demand for labor and helps to reduce the regional unemployment rate. Outward foreign direct investment and the share of investment from Taiwan to Mainland China reduces demand for labor as traditional labor-intensive industries move out of the country to invest offshore and hence this increases the regional unemployment rate.

As this paper finds both equilibrium and disequilibrium factors are important sources

affecting the discrepancy in Taiwan's regional unemployment rate, hence the findings render different implications. Disequilibrium factors include demographic structure, family background, house ownership and labor migration. The aging of the Taiwanese economy due to a low fertility rate and death rate may act to reduce regional unemployment rates especially in the urban areas. The trends of the increasing rate of divorce or being a single woman will likely reduce the regional unemployment rate as those women tend to enter the labor market and find a job to support themselves. The traditional idea of land being the sole property together with restricted investment instruments and opportunities regulated by financial authority can cause the higher ratio of house ownership, which increases the cost of migration and retards labor mobility and results in higher regional unemployment rates. In this regard, policies that foster the development of rental market and enlarge diverse investment instruments by further financial liberalization may benefit regional employment. The increase in real wage not only increases the standard of living, but also stimulates demand spillover which is beneficial to the local labor market. Out-migration signals low job opportunity for a region and thus increases the local unemployment rate. For those regions, policies toward more local attractions may be required to deal with those externalities.

From the future perspective, the fading of family values among the younger generation is detrimental to the incentive of working and thus increases the regional unemployment rate, and rapid resource mobilization under globalization will weaken the concept of house ownership, which is good for labor mobility and thus reduces the regional unemployment rate. Under global competition, Taiwan's industrial structure will shift towards a more high-tech and high value-added orientation and this will certainly create structure unemployment. However, this may be mitigated to some degree by the supply of potentially more educated workers due to the recent expansion of higher education facilities.

This paper intends to identify factors that explain the discrepancies of regional unemployment in Taiwan. Aside from macro variables, important factors in explaining regional unemployment include demographic structure, labor composition and migration, industrial structure, and population density. Different sources of generating unemployment may offer different implications. From policy point of view, knowing these important sources of regional unemployment will help the government formulate appropriate policies to reduce the long-run unemployment rate across regions.

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