Spatial spillovers in Taiwan's unemployment

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Abstract

The overall unemployment rate in Taiwan has risen significantly since 2000. While this drastic change has caught the attention of many researchers in Taiwan, none of the studies has considered the spatial spillovers across regions. By utilizing Taiwan's regional unemployment rates as an example, this paper takes into account regional-specific characteristics, the macro-environment and spatial spillovers simultaneously. Our empirical results show that spatial spillovers, not only from neighboring regions but also from second-order lag regions, have a significant impact on Taiwan's regional unemployment rates. Therefore, should the government attempt to adopt any policies to solve the unemployment problem in certain target regions, it should consider not only the region itself, but also the economic conditions of the neighboring regions together.

Keywords: regional labor market, the spatial-lag unemployment rate factor, spatial spillover, panel dataset

JEL Classification: J64, R23

1. Introduction

The overall unemployment rate in Taiwan has risen significantly since 1996. By observing the unemployment rates of Taiwan from 1982 to 2005 (see Table 1), we can see that the overall unemployment rates were around 2-3% before 1987, and they were even less than 2% between 1988 and 1995. However, the values of unemployment rates went up significantly from 1996 and jumped to 4.6% in 2001. More than that, the unemployment rate reached a peak in 2002, and then slowed down after the Taiwanese government implemented various employment expansion policies. This drastic change in the unemployment rates in Taiwan has caught the attention of researchers, and Jiang (1997, 2001b), Liu and Tong (2001), Chou (2002), and Shin (2005) have all pointed out that economic conditions and industrial structural changes are primary factors affecting Taiwan's overall labor market. Chen (2001), Lin (2002) and Chang (2005) have stated that the natural unemployment rate in Taiwan has also increased as the unemployment rate has risen. These studies suggest that lower rates of unemployment might not be seen again in Taiwan. In addition, we can also learn from Table 1 that the unemployment rate differentials between regions (MAX-MIN) and the variances were much larger *before* 1988. After 1988, the values become much smaller; moreover, in 2005, the value of (MAX-MIN) narrowed down to only 0.5%, and the variance was 0.017.

In a survey article, Elhorst (2000), indicated that spatial interactions can create spatial spillover effects between regions within a country which, in turn, results in a clustering effect on unemployment. Bronars and Jansen (1987) and Molho (1995) reported that unemployment differentials, caused by local shocks, resulted in significant spatial spillovers both in the UK and the US. Furthermore, Lopez-Bazo et al. (2002) indicated that the spatial interactions have given rise to a neighbor effect in Spain's regional labor market and they show that the spatial distribution is far from being random, or homogeneous. In Spain's provinces, by contrast, the unemployment rate in a province is specifically positive in relation to its surrounding provinces. Niebuhr (2003) confirmed that there *do* exist neighbor effects across 359 European regions. She also concluded that neighboring unemployment rates, as well as employment growth rates, are important factors when examining regional unemployment rates. Patacchini and Zenou (2007) indicated that the spatial interactions are quite localized and that they decline sharply with distance in regard to the UK's local unemployment rates. The main reason for the spatial correlation is the fact that workers can search for a job and work in a different area, thus creating commuting flows.

However, such a spatial effect has not been examined in the case of Taiwan's labor market. Liu and Huang (2003) utilized a panel dataset from 1996 to 2002 to consider only the regional-specific characteristics in Taiwan's regional unemployment. By using the ordinary least-squares method, they found that the ratio of males, age, human capital, industrial structures and log wages of the previous year were the primary regional-specific characteristics that contributed to regional unemployment. In another study, Jiang, Tong and Liu (2003) adopted "two-factor fixed effect models" and utilized a panel dataset from 1987 to 2000 that confirmed that, besides macro-environment variables, regional-specific characteristics were also shown to be important factors influencing Taiwan's regional unemployment rate[1]. Both studies confirmed that regional-specific characteristics are the most important factors affecting Taiwan's regional unemployment. In addition, Jiang et al. (2003) pointed out that there is a spread of Taiwan's regional unemployment; as the average unemployment rate is rising, while the variance has converged rapidly in recent years. Although they argue that this may due to a significant neighbor effect in Taiwan's regional labor market, nevertheless, they do not provide any empirical evidence.

1 Jiang and Liu (2005) re-estimate the data from 1987 to 2001 and obtain similar results.

In this paper, it is argued that the spatial interactions between different regions should be one of the key factors when examining the changes in regional unemployment rates in Taiwan. This is because the spatial interactions will likely give rise to spatial spillovers when a region suffers an external shock, for this will subsequently influence its neighboring or economically connected regions quite significantly. Although regional science researchers have introduced spatial interactions into their studies, none of the studies referred to above have taken regional-specific characteristics, the macro-environment and spatial spillovers into consideration simultaneously in their empirical estimates. In addition, in this paper we also construct a second-order lag variable of the spatial-weighted average unemployment rates to specifically take into the account the impact of distances. It is hoped that the above more comprehensive estimation method can provide a relevant example to handle the regional unemployment problem.

In organizing this paper, Section 2 focuses on some of the statistics in Taiwan's regional labor market. Section 3 then introduces an empirical model that is built on the spatial weight matrix. We also discuss why the empirical model adopted in this study is more complete when it comes to examining regional unemployment. In Section 4, we will explain the data that will be employed and its corresponding expected effects in our empirical testing. Our major empirical results will be presented and discussed in Section 5, in which three different models used to capture the importance of this spatial spillover effect will be examined in detail. Moreover, besides using an urban dummy variable, we also divide our sample into two groups to understand the differences between urban and non-urban regions. Finally, we shall summarize our findings before concluding in Section 6.

2. Taiwan's Regional Labor Market

Taiwan covers an area of approximately 36,000 square kilometers and is longer than it is wide. There are 25 administrative districts in Taiwan. Among these 25 regions, Peng-hu, Kin-men and Lien-chiang are all located on offshore islands[2]. In this section, besides the regional statistics, we will also observe the different features of urban and non-urban regions. The urban regions include the seven leading cities: Taipei city, Kaohsiung city, Kee-lung city, Hsin-chu city, Tai-chung city, Chia-yi city and Tai-nan city. The non-urban regions include all other regions except the three offshore counties, which we referred to earlier. From a geographical point of view, neighboring counties surround these 7 urban regions. For example, Taipei city is surrounded by Taipei county, Tai-chung municipality is surrounded by Tai-chung county, etc. As such, the interaction should be strong between cities as well as between the cities and their adjoining counties.

Various regional statistics are presented in Table 2. First of all, the overall population density was 2,069 persons per square kilometer in 1991 and this figure rose to 2,271 in 2005. The urban areas are around 10.25 times more crowded than non-urban areas, but this figure exhibited a slight decrease in 2005 (it was 10.66 times in 1991). This shows that workers have obviously flowed out to the non-urban areas. As for the regional unemployment rates, from Figure 1 and Table 2 it can be seen that both the mean and variation were higher in the urban regions, but the differentials between city and county had declined. Even in 2005, the average regional unemployment rate in the counties was higher than that in the urban regions.

The share of males also decreased. Especially in the urban areas, the female population has exceeded the male populations since 1995. Workers were on average 41.80 years old in 2005, which was much higher than the corresponding figure in 1988 of 37.27 years old. This was because the birth rate decreased rapidly from 17.24% in 1988 and fell

[2] A map of Taiwan is included in the appendix for reference.

to 9.06% in 2005[3]. Furthermore, the expansion in higher education also delayed people's entry into the labor market and let the working population become older.

The male labor force participation rate (MLFPR) remained around 70%, but the female labor force participation rate (FLFPR) increased slightly from 48.87% in 1988 to 53.37% in 2005. In addition, from 1988 onwards, the FLFPR in the urban areas became a little higher than the corresponding rate in the non-urban areas. Furthermore, the average mean and variance for the wage were larger in the urban regions.

In terms of education levels, the proportion of highly-educated workers obviously increased. The ratio of workers with at least a college diploma (EDUH) was 29.15% in 2005, the value being 2.65 times that for 1988 in urban areas, and in non-urban areas, the ratio of workers at least with a college diploma (EDUH) in 2005 was even higher, being 3.04 times that for 1988. As for the industry structure, 70% of workers were employed in the service sector in 2005. The percentage of those employed in that sector in the urban areas was 10% higher than in the non-urban regions. In addition, in general, the ratio of workers in the manufacturing sector did not change a lot, but it clearly decreased in the urban regions.

3. Empirical Model

In a typical empirical model, regional dummy variables are frequently adopted so as to capture differences between regions. However, if there are many regions being simultaneously examined, such a deployment of dummy variable modeling will not only result in a large number of the degrees of freedom being lost, but also, as argued by Cliff and Ord (1981) and Anselin (1988), it will fail to take into account the dependence (spatial auto-correlation) and heterogeneity (spatial structure) between regions. Lopez-Bazo et al. (2002) stated that it is important to note that spatial interactions across regional labor

[3] This statistic is obtained from a survey conducted by the Ministry of the Interior, R.O.C. (Taiwan)

markets may be the result of workers in a region being willing to fill vacancies in other regions, and of firms looking for workers outside the regions in which they are located. If this is true, each region's own labor market will become relevant to other regions' unemployment situations, geographical location, industrial structure, as well as unit labor costs. Therefore, one may consider utilizing a spatial weight matrix (W_{ij}) to capture the potential interactions between two spatial units.

Niebuhr (2003) has argued that among all the spatial interaction factors, *distance* is undoubtedly the most important one. In addition, it can also be argued that the business contacts between regions will become more likely if the regions have longer borders or are separated by shorter distances. Clearly, if a region is closer to another affected region, the decisions or behavior of both firms and workers are influenced directly.

The literature, as in studies by Lopez-Bazo et al. (2002), Overman and Puga (2002), and Niebuhr (2003), treats the neighboring regions' weighted unemployment rates as if they capture such spatial dependence effects. In the case of region i, if region j shares the same border with region i, they set the spatial weight (w_{ij}) equal to 1, or 0 otherwise. Thus, they compute an average unemployment rate of the neighboring regions ($\sum_{j=1}^{n} w_{ij} U_{jt} \big/ k$) ($k$ is the number of neighboring regions), which is called "the factor of the spatial lag of the unemployment rate". Therefore, after considering the regional-specific characteristics, as well as the spatial interactions within a country with n regions, the model for regional unemployment rates in each region could be set as:

$$U_{it} = \alpha_i + \beta_{it} X_{it} + \theta_{jit} (\sum_{j=1}^{n} w_{ij} U_{jt} \big/ k) + \varepsilon_{it} \qquad i, j = 1,..., n \quad (i \neq j); \quad t = 1,..., z \qquad (1)$$

In equation (1), U_{it} represents the observed unemployment rate in region i in year t; X_{it} represents the regional-specific characteristics in region i in year t; U_{jt}

represents each region's unemployment rate in year t except region i; $\sum_{j=1}^{n} w_{ij} U_{jt} \big/ k$ is the average unemployment rate of the neighboring regions and, as such, θ_{jit} is the average spatial spillover effect from the neighboring regions to region i. Their empirical results all support the view that the spatial lag factor *does* positively affect the regional unemployment rate. In other words, regions adjacent to a high-unemployment region are bound to be hard hit by high unemployment rates and vise versa. In short, it appears that unemployment tends to cluster in regional labor markets.

We can see in equation (1) that the authors do not take into account the overall economic environment of a country. As Shepherd and Dixon (2002), Jiang et al. (2003) and Jiang and Liu (2005) argue, the overall economic environment as well as regional characteristics have significant impacts on regional unemployment rates in both Australia and Taiwan. Therefore, in our study, we not only incorporate regional spatial spillover factors and regional specific factors, but also incorporate several important macro-environmental variables to capture all possible macro-shocks into our model estimates. As such, a more comprehensive model that examines regional unemployment rates will be the model specified as follows:

$$U_{it} = \alpha_i + \sum_{i=1}^{n} \beta_{it} X_{it} + \sum_{m=1}^{l} \phi_{mt} M_{mt} + \theta_{jit} \Big(\sum_{j=1}^{n} w_{ij} U_{jt} \Big/ k\Big) + \varepsilon_{it} \qquad (i \neq j) \qquad (2)$$

The definitions of U_{it}, X_{it}, $\sum_{j=1}^{n} w_{ij} U_{jt} \big/ k$ and θ_{jit} are the same as those for equation (1); M_{mt} is the overall economic environment, and *m* is the number of potential factors. As shown in equation (2), the determinants of the regional unemployment rate consist of three types of factors, namely, regional-specific characteristics (X_{it}), a set of macro-environmental variables (M_{mt}) and regional interactions ($\sum_{j=1}^{n} w_{ij} U_{jt} \big/ k$).

4. Data Description

In the following subsections we utilize Taiwan's regional unemployment rates as an example to examine the empirical model in equation (2), and we begin our discussion by explaining the relevant Taiwanese data sets.

4.1 Data resources and Districts

The main dataset in our study is the Manpower Utilization Survey (MPU)[4]. Based on the discussion above, spatial interaction is important to regional unemployment. However, there are three counties in Taiwan, namely, Peng-hu, Kin-men and Lien-chiang, that are all located on separate islands away from the main island Taiwan. Due to the transportation being inconvenient, the interactions with other regions are relatively infrequent. As such, we exclude these three counties from our study.

It is also worth noting that Krugman (1991) highlighted the fact that the 'administrative districts' cannot reflect the interactions between 'economic districts'. In addition, Overman and Puga (2002) also pointed out that unemployment clusters in European countries encompass parts of different regions and nations, which indicates that the "administrative districts" *cannot* appropriately capture the spatial interactions between "economic districts". However, due to the lack of data, most studies adopt "administrative districts" as the criterion when discussing regional unemployment differentials.[5] Therefore, we construct a panel dataset of 22 regions in Taiwan from 1982 to 2005. In addition to this, besides the MPU datasets, we have also incorporated four macro-environmental variables with data sources from Employment Service Statistics, the Annual Report of Labor Statistics, and the Annual Report of Economics Statistics, which

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4 MPU is the most important labor market survey in Taiwan and the official monthly and annual unemployment rates and labor force participation rates statistics are all compiled from these surveys.

5 Lopez-Bazo et al. (2002), Shepherd and Dixon (2002), Overman and Puga (2002), Niebuhr (2003), Jiang et al. (2003), Liu and Huang (2003), and Jiang and Liu (2005) all adopt "administrative districts" in their studies.

are all major official statistics compiled by relevant government agencies.

4.2 Variables

(1) Spatial lag

As we mentioned earlier, Niebuhr (2003) argued that, among all spatial interaction factors, *distance* is undoubtedly the most important one. Most studies, in general, utilize the “distance inverse” to measure the effect of distance. However, this kind of setting cannot take into account the effect of boundaries. In this regard, and in a departure from the literature, in addition to the neighbor effect (w_{ij}^1) as in Lopez-Bazo et al. (2002), Overman and Puga (2002) and Niebuhr (2003), we construct a second-lag spatial weight, which is called w_{ij}^2, to examine whether distances *do* matter in Taiwan’s regional labor market.

Blommestein (1985) and Anselin (1988, 2006) mentioned that higher-order contiguity matrices include paths that are already partially contained in a contiguity matrix of lower order. Consequently, an uncritical interpretation of these linkages would lead to double-counting problems. In this respect, in order to ensure that the parameters in a higher-order model are properly identified and to avoid biased estimates, we set the spatial weights in such a way that they do not overlap. As such, we set w_{ij}^2 equal to 1, if the distance between the regions is shorter than 100 kilometers (thus eliminating the neighboring regions), and to 0 otherwise. Therefore, for region i, the first and the second lags of the spatial-weighted average unemployment rates are:

$$WU1_{it} = \sum_{j=1}^{n} w_{ij}^1 U_{jt} \Big/ k \quad (k \text{ is the number of first-order spatial-lag regions})$$

$$WU2_{it} = \sum_{j=1}^{n} w_{ij}^2 U_{jt} \Big/ h \quad (h \text{ is the number of second-order spatial-lag regions})$$

The classifications of the first-order and the second-order spatial-lag regions are listed in Table 3. In general, the spatial spillovers will decay as the distances increase. Therefore, it is expected that $WU1_{it}$ and $WU2_{it}$ will both have a positive impact on the regional unemployment rates, but the impact of $WU1_{it}$ will be larger than that of $WU2_{it}$.

(2) Regional-specific characteristics

All variables in the regional-specific characteristics are calculated from the MPU database in our study[6]. The definitions and measurements are listed in Table 4.

Many studies have pointed that the effect of the participation rate on unemployment is negative, since a lower participation rate reflects relatively low investment in human capital and a short working life[7]. Moreover, Lopez-Bazo et al. (2002) also confirmed that the female labor force participation rate will have a negative impact on regional unemployment. However, it was argued in Elhorst (1998) that this negative impact may be dampened by low participation rates and that this is because a low participation rate implies that a region has higher disguised unemployment. As such, in this study, we do not intend to make any predictions regarding the sign of the female labor force participation rate ($FLFP_{it}$).

The possible relationship between regional wages ($WAGE_{it}$) and regional unemployment is also quite controversial. The spatial equilibrium model asserts that a high risk of unemployment is often compensated by a higher real wage of a region (Molho, 1995). The job search theory echoes such a positive effect by stressing that the optimal search strategy for an individual is to accept the wage offered that exceeds the reservation wage. Hence, the job matching process may take place more quickly when there exists a

[6] The regional characteristic variables are used in the empirical studies in Jiang (2003) et al., Liu and Huang (2003), and Jiang and Liu (2005) that all adopt the MPU database of Taiwan.

[7] Elhorst (2000), Fleisher and Rhodes (1976), Siegers (1983), Van der Veen and Evers (1983), Hofler and Murphy (1989), Blanchard and Katz (1992), and Decression and Fatas (1995) all agree on this negative relationship.

higher wage rate. By contrast, however, the efficiency wages theory[8] states that a region with higher wage compensation may attract workers to move in and worsen the unemployment situation. Liu and Huang (2003), however, found that, in the case of Taiwan, the high wage rate regions are those with higher productivity and better economic conditions, which would also be indicative of a relatively low unemployment rate. Therefore, in light of the previous studies for Taiwan, we expect that $WAGE_{it}$ will affect the unemployment rate negatively.

Jiang (2003) has pointed out that workers who are 50 years old or older have low human capital and cannot be employed as easily after quitting or after having been laid off. Liu and Huang (2003) also argued that marginal workers (like teenagers and the elderly) may face higher unemployment risks during a recession. However, in comparison with teenagers, workers who are over 50 may be shouldered with heavier burdens and will tend to stay in the job market in order to find new work opportunities. Consequently, it is not surprising to find that the unemployment rate for this group will be much higher. Under such circumstances, we would expect the sign of AGE_{it} to be positive. Furthermore, as in the case of the argument in Lopez-Bazo et al. (2002), Jiang et al. (2003) and Jiang and Liu (2005) have observed that less educated and low-skilled workers exhibit high risks of unemployment. From examining the unemployment rates by educational level from 1982-2005 as in Figure 2, however, the unemployment rates of workers with at least a high school education, or at least five years of college or a university diploma are much higher than those who have less than a junior high school education. As such, we expect $EDUM_{it}$, $PROF1_{it}$ and $PROF2_{it}$ to each positively contribute to the regional unemployment rates, but the effect of $EDUL_{it}$ is uncertain.

Molho (1995), Taylor and Bradley (1997), Bandinger and Url (2002), Lopez-Bazo et

[8] Like Marston (1985), Layard, Nickel and Jackman (1991).

al. (2002) and Murphy and Payne (2003) all argued that the industrial structure significantly affects the regional labor market. It is also argued that regions concentrated in declining industries such as agriculture and manufacturing are expected to exhibit higher unemployment rates than regions specializing in growing industries, such as marketing and public services. From Table 2, it can be seen that the proportions of those employed in the manufacturing sector were around 24-28% from 1982 to 2005, but in the service sector they were growing from 63.03% in 1982 to 70.50% in 2005. From the arguments above, therefore, we can expect that regions with higher proportions of manufacturing sector employed may have higher unemployment; in other words, the coefficient for labor in the manufacturing sector ($SECD_{it}$) will be positive. Although it is often believed that regions with higher proportions of those employed in the service sector will tend to have lower unemployment, growing industries are no guarantee that the unemployment rate will be reduced, since non-participants may enter the labor market. When the labor supply effects are strong, the regional unemployment rate may remain unaffected, or may even become higher. By surveying the overall labor force participation rate from 1981 onwards, it can be observed that the value does not change very much. However, the FLFPR is seen to increase significantly from 38.76% in 1981 to 48.68% in 2006 over these 25 years. Moreover, the number of workers in the service sector increases drastically from 2,587 thousand to 5,914 thousand over this same period, in which the proportion of female workers in the service sector increases from 35% to 50.52%. These statistics show that the labor supply effect seems to be very strong in the service sector. Therefore, we do not make any predictions regarding the sign for labor in the service sector ($THIRD_{it}$).

(3) Macro-environment

We utilize three macro-environment variables in this study, namely, the labor demand/supply ratio (DSR_t), the employment ratio in the construction sector ($BUILD_t$), and the minimum wage index (MWA_t)[9]. First of all, DSR_t is able to reflect both labor demand and labor supply simultaneously. The DSR_t will tend to have a larger value if the labor demand is relatively higher in that year. As such, the labor market could be improved, so that we could expect that the DSR_t will lower the regional unemployment rates. Moreover, Jiang et al. (2003) and Jiang and Liu (2005) have argued that due to the strong industrial linkages among many upstream and downstream sectors, the employment in the construction sector ($BUILD_t$) is expected to lower the regional unemployment rates. Moreover, increases in unit labor costs will cause firms to postpone their hiring decisions, which will increase unemployment. In addition to this, most social security or pension payments are based on minimum wages. Thus, increases in minimum wages will burden firms and the unit labor costs will subsequently increase as well. As such, we utilize the minimum wage index (MWA_t) as a proxy for unit labor costs, (as do Jiang et al. (2003) and Jiang and Liu (2005)) and we expect that the variable MWA_t will have a positive effect on regional unemployment rates.

5. Empirical Results

In this study, we construct a panel dataset for Taiwan's regional unemployment rate from 1982 to 2005. Since it is observed that there exists spatial dependence and spatial heterogeneity in regional unemployment, we adopt the instrumental variable method (IV method) in our estimation. Besides, we also list the results of the FGLS method, which corrects for the spatial auto-correlation and heterogeneity, for reference. In addition to this, we also provide three different empirical models to capture the possible importance of spatial spillovers. It is important to note that, as we show in Table 5, Model 1 is similar to

9 The base year of the new registered factories index and the minimum wage index is 2000.

the models in Jiang et al. (2003) and Jiang and Liu (2005), which consider both the macro environment and the regional characteristics. Model 2 is similar to Lopez-Bazo et al. (2002), Overman and Puga (2002) and Niebuhr (2003), who adopt spatial-lag variables instead of the macro-environmental variables as in equation (1). However, we construct two spatial weight matrices, namely, the first- and the second-order spatial lag. Model 3 is how we argue that the regional characteristics, the macro-environment, and spatial spillovers should all be taken into account in examining regional unemployment as in equation (2).

Moreover, more developed urban areas usually have more business activities and they are usually more labor-clustered areas as well. Therefore, we add an urban dummy to observe the effect of urbanization. Besides, in order to realize the possible effect of the different factors, we also divide our sample into two groups. The first includes the seven major cities in Taiwan as one sample, which is called the ‘urban’ group, and the second sample contains all other counties apart from these seven top regions and they are classified as the ‘non-urban’ group.

5.1 The overall results

The empirical results of all regions are listed in Table 5. We will compare the IV method result of the full model, i.e., Model 3, with two other models. First of all, of all the regional characteristics in Model 3, $FLFP_{it}$, $WAGE_{it}$, AGE_{it}, $PROF1_{it}$, $SECDS_{it}$ and $THIRD_{it}$ are significant. The female labor force participation rate ($FLFP_{it}$) has a negative sign and is significant at the 1% level. This result is consistent with the finding for Spain in Lopez-Bazo et al. (2002). Since the lower participation rate reflects relatively low investment in human capital and a short working life, it results in higher risks for people with these characteristics of becoming unemployed.

The regional wage levels ($WAGE_{it}$) negatively and significantly affect the regional unemployment rates. Our finding is consistent with those of many previous studies, and also Liu and Huang (2003) for the case for Taiwan, in that the high wage rate regions are those with higher productivity and better economic conditions, which would be characterized by a relatively low unemployment rate. In addition, variable AGE_{it}, as we expected, is significantly positive in regard to regional unemployment. Our finding is consistent with Jiang (2003) and Liu and Huang (2003) in that workers who are over 50 may be shouldered with heavier burdens and will tend to stay in the job market in order to find new work opportunities.

As for the human capital variables, in Model 3 only $PROF1_{it}$ reaches the 5% significance level. The results show that the regions with higher ratios of low-skilled employed persons tend to face higher unemployment. However, in Model 1, our finding shows that the low-educated ratio ($EDUL_{it}$) negatively affects the regional unemployment rates. As we have mentioned in Figure 2, low-educated workers in Taiwan tend to have lower unemployment rates. One possible explanation is that, by examining the labor force participation rate (LFPR), it is seen that the LFPR of workers with less than a junior high school education decreased from 57.60% in 1982 to 45.53% in 2005. On the other hand, the LFPR of workers with at least a high school education was over 60% in 2005.[10] As Elhorst (1998) has argued, a low participation rate implies that there exists a high state of disguised unemployment. Therefore, the actual unemployment rate of low-educated workers might be underestimated, leading to a negative relationship between $EDUL_{it}$ and the regional unemployment rates. However, it becomes insignificant after considering the spatial interactions in Models 2 and 3.

As for the industry mix, $SECDS_{it}$ is significantly positive as expected. Our finding

[10] From MPU, the LFPRs of workers with a high school diploma are 55.75% and 63.45% in 1982 and 2005, respectively. The LFPRs of workers at least with a college diploma are 65.09% and 66.40% in 1982 and 2005, respectively.

is consistent with the argument that regions with a higher ratio of workers in declining industries are expected to exhibit higher unemployment rates. Besides, $THIRD_{it}$ is also significantly positively related to regional unemployment rates. This result is similar to that discussed earlier in that a strong labor supply effect may offset the negative relationship between growing industries and regional unemployment.

The regional unemployment rate is lower when the economy is prosperous and has a higher labor demand. As such, the signs of DSR_t and $BUILD_t$ are all negative. However, compared with Model 1, the coefficients are much smaller. Furthermore, in a way that is consistent with Jiang et al. (2003) and Jiang and Liu (2005), when the unit labor cost (MWA_t) increases, firms do not have new hiring plans and labor market conditions will deteriorate.

We can see from the results of Models 2 and 3 in Table 5 that the two spatial-lag variables $WU1_{it}$ and $WU2_{it}$ are both positive and significant. These show that spatial spillovers *do* significantly affect Taiwan's regional labor market. However, one finding that is inconsistent with what we expected is that the coefficient of $WU1_{it}$ is less than that of $WU2_{it}$. As we have discussed in Table 1, the unemployment rate differentials between regions (MAX-MIN) as well as the variances become much smaller *from* 1988 onwards. Therefore, we try to find out whether there are any changes in the effect of these three possible factors, and as such we re-estimate the data in 1988-2005 to realize the effect as the variance declines.

The empirical results for 1988-2005 are listed in Table 6. First, compared with Table 5, of the regional characteristic variables, only $WAGE_{it}$ and two industry-mix variables ($SECDS_{it}$ and $THIRD_{it}$) still reach the significance level. Moreover, the effect of the skills of workers becomes insignificant, which shows that, as the unemployment spreads, the human capital variables may not be the key factors in regional unemployment. In addition, except for DSR_t, the macro-environmental variables still affect the regional unemployment rate significantly.

As for the variables with which we are most concerned, namely, the spatial-lag variables, both $WU1_{it}$ and $WU2_{it}$ are positive and significant in Models 2 and 3 as seen in Table 6. Moreover, the coefficient of $WU1_{it}$ is larger than that of $WU2_{it}$ which represents the decline in spatial interaction as the distances between regions become larger. Our estimates over the 1988-2005 period show that "distances" do matter as many spatial researchers have stated. From our empirical estimates, therefore, when the variances in the regional unemployment rate become smaller, the spatial spillovers between regions become much stronger. On the contrary, the effects of the regional specific characteristics seem to become less important. Moreover, a significantly positive value of $WU1_{it}$, regardless of whether it is found in Table 5 or 6, also proves that there exist neighbor effects across Taiwan's regional labor market, which have been intensively discussed in Jiang et al. (2003) and Jiang an Liu (2005), but without supporting empirical evidence[11]. As such, possible unemployment clusters, as argued in Lopez-Bazo et al. (2002), Overman and Puga (2002) and Niebuhr (2003), are able to be confirmed for the first time through Taiwan's regional labor markets.

5.2 The urbanized level

The empirical results for the urbanized level are listed in Table 7. Because the urban dummy is time invariant, as such we adopt the random effect estimation. Besides the dummy variable setting, in order to realize the possible effect of factors, we also separate our sample into two groups: urban and non-urban. The separated-sample results are

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[11] The panel years in Jiang et al. (2003) and Jiang and Liu (2005) are 1987-2000 and 1987-2001 respectively.

estimated using FGLS, and have been corrected for spatial auto-correlation and heterogeneity. From the discussion above, Model 3 is a more comprehensive model for our empirical estimates and therefore we focus our comparison on Model 3.

Except for the urban dummy and the two spatial-lag variables, in general, most of the results are consistent with Tables 5 and 6 and thus we do not discuss these in detail. The urban dummy variables in Table 7 are both significantly positive in 1982-2005 and 1988-2005. These results show that the urban regions (cities) *do* have higher unemployment rates. As for the two spatial-lag variables with which we are more concerned in this study, as we can see from the results for 1982-2005 in Table 7, both $WU1_{it}$ and $WU2_{it}$ positively affect the regional unemployment rates and reach the 1% significance level, but the coefficient of $WU1_{it}$ is less than that of $WU2_{it}$. However, as the unemployment differential converges, $WU1_{it}$ and $WU2_{it}$ still affect regional unemployment rates positively. Besides, the coefficient of $WU1_{it}$ is larger than that of $WU2_{it}$ in the results for 1988-2005.

In Table 7, the urban regions are significantly affected by regional characteristics and macro-circumstances in 1982-2005. However, the spatial spillovers become much stronger and significant in $WU1_{it}$ for 1988-2005 in cities. These results show that urban regions exhibit huge positive spatial spillovers in their neighboring regions, in other words, from their surrounding counties. Therefore, the performances of the labor markets in these surrounding non-urban areas will surely affect their respective urban centers. As such, our results confirm, for the first time, that there exist neighbor effects in urban areas and that there also exist unemployment clusters around the urban centers in Taiwan.

Furthermore, from our results in Table 7, as the neighbor effects become stronger in the urban regions, the influences of the regional specific characteristics become much weaker. In particular, the four human capital variables, namely, $EDUL_{it}$, $EDUM_{it}$, $PROF1_{it}$ and $PROF2_{it}$, all no longer have a significant influence. In addition, older workers have higher unemployment risks in cities.

The spatial spillovers are quite strong in the non-urban regions. $WU1_{it}$ and $WU2_{it}$ are both positive and the coefficient of $WU1_{it}$ is much larger than that of $WU2_{it}$ in the 1988-2005 period. It is worth mentioning here that, although the educational level might not be the key factor in regional unemployment, "skill" does have a significant effect in the non-urban regions in Taiwan. Moreover, as for macro-environmental variables, the urban regions are more significantly affected by national economic fluctuations than the non-urban regions, since the regression coefficients of $BUILD_t$ and MWA_t are larger in urban groups.

To sum up, our empirical evidence shows that factors related to regional-specific characteristics, the macro-environment and spatial spillovers, are together relevant to regional unemployment rates in Taiwan. It is thus worth paying attention to those spatial interactions between regions when examining the regional unemployment problem. In addition, our empirical results also show that $WU1_{it}$ and $WU2_{it}$ are both positive; and that the coefficient of $WU1_{it}$ is much larger than that of $WU2_{it}$ as the average unemployment rate becomes higher and the variance of regional unemployment rates becomes smaller. These findings suggest that there do exist spatial spillovers in Taiwan's labor markets; and that spatial interactions will decline as the distances between regions become larger. Such a phenomenon becomes increasingly noticeable as the average unemployment rate is rising, while the variance converges.

6. Conclusions

The key to sustainable development in a country is the balanced growth in each region. Therefore, if a country has high unemployment differentials, it presents an inefficient allocation between regions. Many studies indicate that there appear to be significant spatial spillovers across areas within a country but none of the existing studies in the literature have taken regional-specific characteristics, the macro-environment and spatial spillovers simultaneously into consideration in examining such an important question. In this paper, we utilize Taiwan's regional unemployment rate as a means of examining and comparing the empirical results.

To facilitate such a study, we have compiled a panel dataset of 22 regions in Taiwan from 1982 to 2005. Our empirical results show that although regional characteristics still have certain explanatory power in affecting regional unemployment, the spatial interactions between regions are confirmed to be the key factors in regional labor markets. In addition, the first-order spatial-lag variable ($WU1_{it}$) and the second-order spatial-lag variable ($WU2_{it}$) are both positive and significant. Our findings show that there do exist spatial spillovers in Taiwan's regional labor markets. Moreover, as the unemployment differentials become lower, the coefficient of $WU1_{it}$ becomes much larger than that of $WU2_{it}$, which clearly suggests that the spatial interactions decline as the distances between regions grow larger. As such, by utilizing Taiwan's labor market as an example, we are for the first time able to confirm that there exists a regional unemployment clustering effect. After we incorporate $WU1_{it}$ and $WU2_{it}$, our findings also show that human capital may not be the key factor in regional unemployment rates in Taiwan since the four human capital variables become insignificant.

Furthermore, both $WU1_{it}$ and $WU2_{it}$ appear to be significant in the non-urban group, while $WU1_{it}$ reaches a 1% level of significance in the urban group in 1988-2005, which suggests that urban regions are more likely to exhibit higher positive spatial spillovers from their neighboring regions. As such, the performances of the labor markets in these surrounding areas will surely affect their respective urban centers. Our results confirm for the first time that there do exist neighbor effects in urban areas in Taiwan.

To sum up, regional-specific characteristics, macro-circumstances and spatial spillovers are together shown to have a significant impact on Taiwan's regional unemployment rates. Therefore, in examining the regional unemployment problem, one should incorporate all three factors, so as to make the specifications of the model as comprehensive as possible. Among all these factors, our empirical results have confirmed that the spatial spillover is one of the most important factors affecting regional unemployment rates in Taiwan. Therefore, if the government tries to adopt any policy to solve the unemployment problem in certain target regions, it should consider not only the region itself, but also the economic conditions of the neighboring region so as to solve the problem more effectively.

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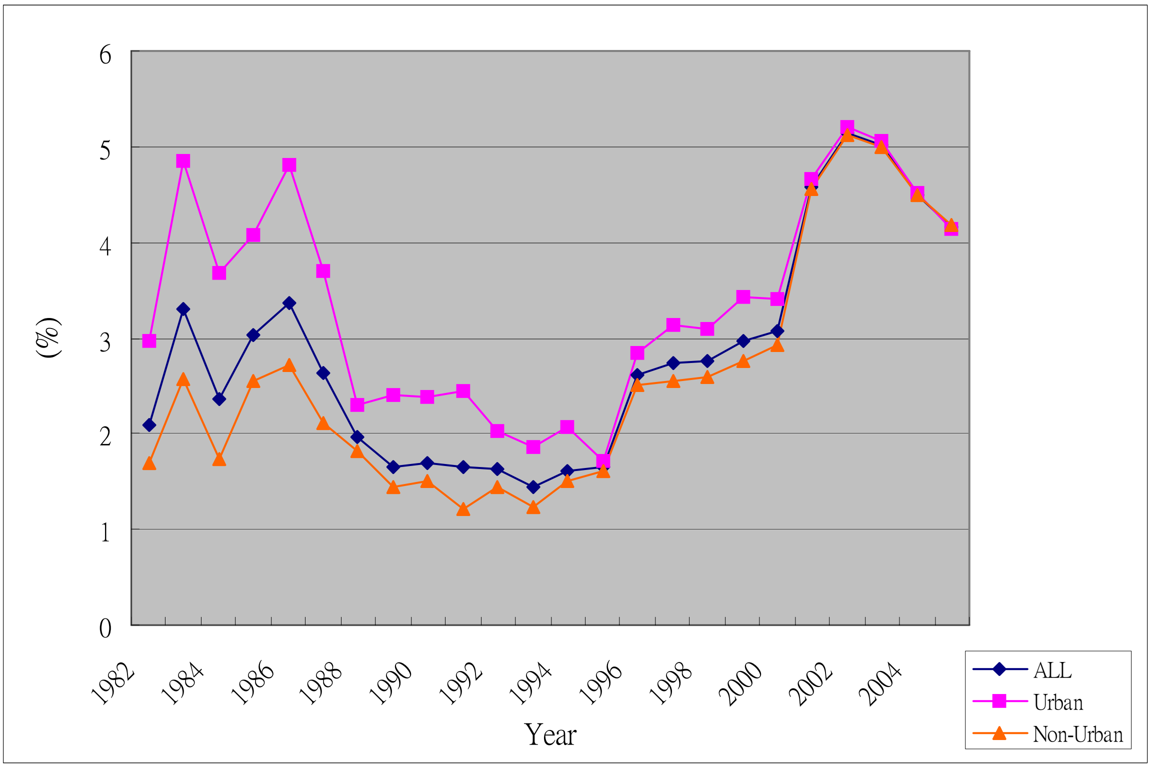


Figure 1 Regional unemployment rates by urbanized level

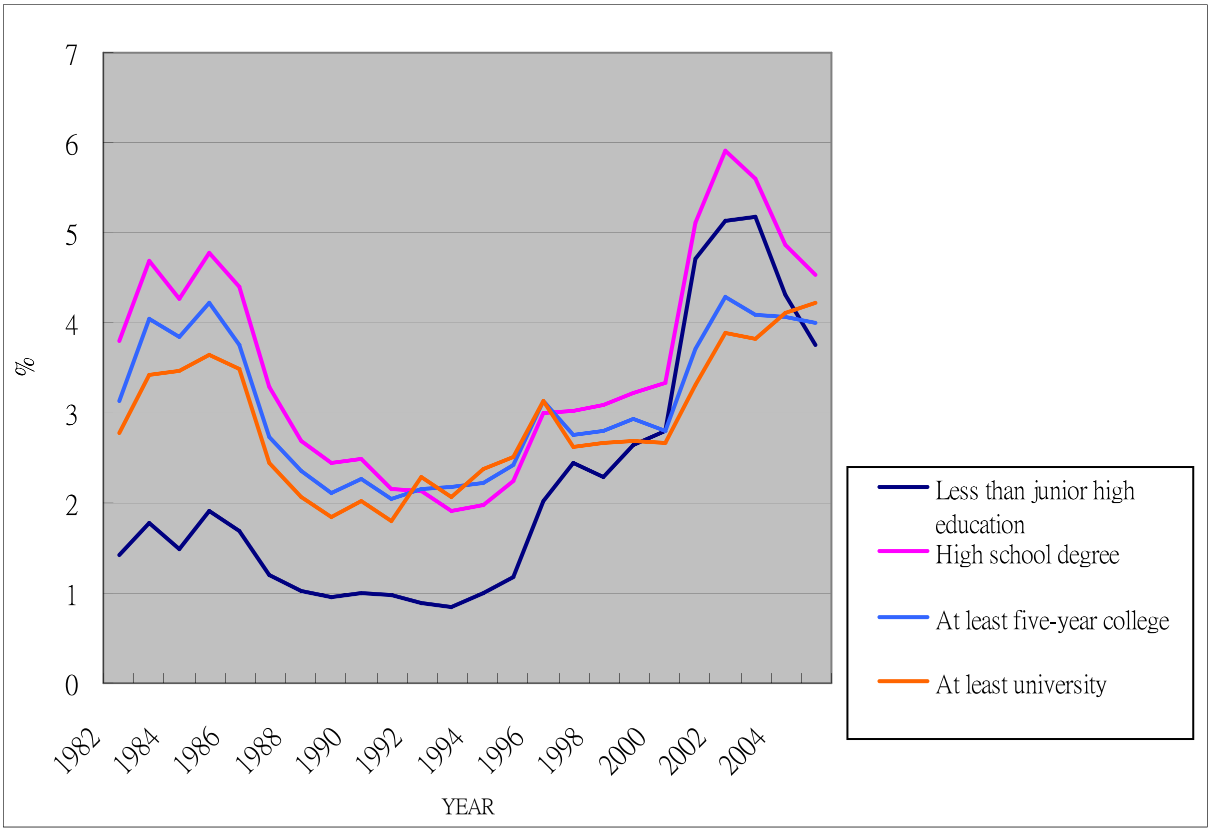


Figure 2 The unemployment rates by educational level (1982-2005)

Source: National Statistics, R.O.C. (Taiwan), DGBAS, Executive Yuan.

Table 1 Statistics for Taiwan's Regional Unemployment Rate: 1982-2005

Year	Mean	Variance	MAX - MIN	Year	Mean	Variance	MAX - MIN
1982	2.09	1.049	3.30	1994	1.60	0.207	2.10
1983	3.30	2.197	9.35	1995	1.79	0.228	1.80
1984	2.36	1.333	5.91	1996	2.60	0.365	2.10
1985	3.03	1.434	4.79	1997	2.72	0.469	2.50
1986	3.37	2.666	7.14	1998	2.70	0.348	2.30
1987	2.63	1.791	5.34	1999	2.90	0.653	3.10
1988	1.97	0.358	2.24	2000	2.99	0.627	2.60
1989	1.65	0.671	4.02	2001	4.57	0.231	1.60
1990	1.70	0.709	3.00	2002	5.20	0.156	1.50
1991	1.65	0.859	3.80	2003	5.00	0.088	1.10
1992	1.63	0.502	2.69	2004	4.50	0.066	1.00
1993	1.45	0.302	2.70	2005	4.17	0.017	0.5

Source: Calculated by authors.

Table 2 Regional Statistics

	Population Density			*Share of males*			*AGE*			*UNR*		
YEAR	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*
	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)
1988	---	---	---	52.41	50.90	53.11	37.27	36.70	37.53	1.97	2.31	1.81
				(1.47)	(0.95)	(1.09)	(0.81)	(0.75)	(0.71)	(0.60)	(0.52)	(0.58)
1989	---	---	---	52.23	51.01	52.80	37.64	37.11	37.90	1.65	2.40	1.45
				(1.35)	(0.95)	(1.11)	(0.95)	(0.55)	(1.02)	(0.82)	(1.12)	(0.55)
1990	---	---	---	51.79	50.89	52.21	37.94	37.43	38.18	1.70	2.39	1.50
				(1.10)	(1.02)	(0.89)	(0.98)	(0.93)	(0.94)	(0.84)	(1.05)	(0.69)
1991	2069.22	5414.45	508.11	51.90	50.95	52.35	38.22	37.73	38.46	1.65	2.44	1.21
	(2833.11)	(2360.80)	(332.27)	(1.49)	(1.39)	(1.35)	(1.15)	(1.25)	(1.07)	(0.93)	(0.79)	(0.44)
1992	2082.97	5443.66	514.65	51.79	50.44	52.42	38.44	37.84	38.73	1.63	2.03	1.44
	(2835.79)	(2338.72)	(337.99)	(1.55)	(1.32)	(1.24)	(1.11)	(0.67)	(1.18)	(0.71)	(0.59)	(0.62)
1993	2090.55	5451.66	522.04	51.61	50.05	52.34	38.57	38.04	38.83	1.45	1.86	1.23
	(2820.84)	(2288.08)	(343.84)	(1.38)	(0.66)	(0.93)	(0.95)	(0.70)	(0.97)	(0.55)	(1.16)	(0.29)
1994	2105.83	5487.27	527.83	51.61	50.05	52.34	38.73	38.24	38.96	1.60	2.06	1.51
	(2834.88)	(2288.36)	(348.88)	(1.45)	(0.88)	(1.01)	(1.01)	(0.71)	(1.07)	(0.45)	(0.66)	(0.61)
1995	2119.46	5516.75	534.06	51.53	49.78	52.34	38.93	38.48	39.15	1.65	1.71	1.62
	(2839.71)	(2267.94)	(354.55)	(1.57)	(0.90)	(1.05)	(1.01)	(0.73)	(1.07)	(0.47)	(0.47)	(0.56)
1996	2134.11	5550.13	539.97	51.53	49.77	52.34	39.07	38.68	39.26	2.61	2.84	2.50
	(2842.23)	(2234.08)	(360.39)	(1.67)	(1.03)	(1.21)	(1.03)	(0.84)	(1.09)	(0.60)	(0.71)	(0.53)
1997	2151.42	5590.29	546.61	51.48	49.71	52.31	39.32	38.86	39.54	2.74	3.13	2.55
	(2850.94)	(2208.59)	(366.91)	(1.74)	(0.93)	(1.37)	(1.04)	(0.82)	(1.09)	(0.66)	(0.75)	(0.54)
1998	2177.40	5663.11	550.73	51.31	49.56	52.13	39.60	39.12	39.83	2.76	3.10	2.60
	(2896.95)	(2259.21)	(372.13)	(1.72)	(1.05)	(1.31)	(1.08)	(0.82)	(1.15)	(0.56)	(0.66)	(0.45)
1999	2197.77	5717.17	555.38	51.29	49.39	52.18	39.89	39.35	40.15	2.96	3.43	2.75
	(2918.82)	(2265.26)	(377.90)	(1.76)	(0.96)	(1.26)	(1.21)	(0.98)	(1.26)	(0.74)	(0.66)	(0.69)
2000	2219.98	5776.19	560.41	51.29	49.25	52.24	40.16	39.70	40.38	3.07	3.40	2.92
	(2944.53)	(2292.16)	(383.91)	(1.86)	(0.96)	(1.32)	(1.11)	(0.87)	(1.17)	(0.75)	(0.64)	(0.76)
2001	2232.68	5807.56	564.39	51.41	49.39	52.36	40.42	39.97	40.64	4.58	4.66	4.55
	(2951.16)	(2290.50)	(388.29)	(1.85)	(0.96)	(1.31)	(1.11)	(0.89)	(1.17)	(0.43)	(0.44)	(0.45)
2002	2247.78	5848.47	567.46	51.39	49.48	52.28	40.75	40.35	40.94	5.15	5.21	5.13
	(2972.85)	(2314.65)	(392.32)	(1.81)	(1.11)	(1.31)	(1.09)	(0.91)	(1.15)	(0.32)	(0.32)	(0.33)
2003	2255.44	5865.87	570.57	51.16	49.28	52.04	41.13	40.75	41.31	5.01	5.06	4.99
	(2973.32)	(2306.14)	(396.10)	(1.77)	(0.95)	(1.31)	(1.12)	(0.92)	(1.19)	(0.28)	(0.23)	(0.31)
2004	2264.60	5888.66	573.37	51.12	49.17	52.04	41.46	41.13	41.62	4.50	4.51	4.49
	(2980.41)	(2308.70)	(400.09)	(1.78)	(0.93)	(1.26)	(1.12)	(0.93)	(1.20)	(0.25)	(0.17)	(0.28)
2005	2271.03	5902.90	576.16	51.07	49.04	52.02	41.80	41.48	41.96	4.17	4.14	4.18
	(2982.11)	(2306.39)	(403.74)	(1.82)	(0.89)	(1.26)	(1.13)	(0.94)	(1.22)	(0.13)	(0.13)	(0.14)

Table 2 Regional Statistics (Cont.)

	MLFPR			*FLFPR*			*WAGE*		
YEAR	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*
	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)
1988	71.87	69.36	73.03	48.87	45.73	50.33	14605.05	15950.12	13977.36
	(3.63)	(1.99)	(3.67)	(7.20)	(5.27)	(7.66)	(1415.75)	(1584.02)	(777.46)
1989	73.49	72.28	74.06	49.14	47.98	49.69	16969.28	18760.63	16133.32
	(2.94)	(1.39)	(3.32)	(6.30)	(6.98)	(6.15)	(1737.10)	(1760.72)	(918.94)
1990	73.35	71.32	74.29	48.33	46.59	49.15	19321	21049.20	18514.51
	(3.08)	(2.61)	(2.89)	(5.03)	(4.95)	(5.03)	(1828.55)	(1765.77)	(1220.21)
1991	73.82	71.56	74.87	49.20	47.21	50.14	21519.31	23133.86	20765.86
	(3.59)	(1.83)	(3.77)	(5.22)	(4.42)	(5.44)	(1895.35)	(2228.83)	(1160.98)
1992	74.39	71.62	75.68	48.96	46.80	49.98	24186.51	25624.96	23515.23
	(3.95)	(2.06)	(4.00)	(5.79)	(4.28)	(6.24)	(1986.73)	(2282.57)	(1473.23)
1993	74.06	71.92	75.06	49.48	48.58	49.91	26583.37	28444.51	25714.84
	(2.67)	(2.40)	(2.20)	(4.69)	(5.08)	(4.63)	(2262.90)	(2520.89)	(1554.79)
1994	74.26	72.09	75.28	49.56	47.76	50.40	28552.71	30260.73	27755.63
	(2.27)	(1.88)	(1.67)	(4.57)	(5.35)	(4.10)	(2308.08)	(2915.21)	(1486.35)
1995	74.18	72.36	75.03	50.08	49.04	50.58	29805.92	31592.94	28971.97
	(2.25)	(1.70)	(1.98)	(4.60)	(4.45)	(4.74)	(2343.81)	(3212.69)	(1214.44)
1996	72.54	69.66	73.88	50.38	48.67	51.19	31013.00	33664.94	29775.42
	(3.00)	(1.50)	(2.55)	(3.87)	(4.08)	(3.63)	(2557.44)	(2769.89)	(1168.41)
1997	72.60	69.34	74.13	49.83	49.89	49.81	31708.62	34206.71	30542.84
	(3.25)	(2.64)	(2.24)	(4.08)	(5.52)	(3.46)	(2592.54)	(3021.94)	(1261.67)
1998	73.17	70.56	74.39	49.59	50.99	48.93	32498.79	36008.15	30861.08
	(3.33)	(2.37)	(3.05)	(4.68)	(5.60)	(4.24)	3432.887	(3582.83)	(1773.18)
1999	73.06	71.23	73.92	50.13	50.19	50.11	32899.74	36339.65	31294.44
	(2.66)	(2.29)	(2.43)	(3.28)	(4.64)	(2.64)	(3457.84)	(4125.23)	(1401.52)
2000	73.16	71.47	73.96	50.27	51.35	49.77	33087.91	37215.84	31161.54
	(2.48)	(1.61)	(2.44)	(3.59)	(4.13)	(3.34)	(3780.14)	(3955.04)	(1494.83)
2001	71.20	69.20	72.14	50.35	50.71	50.19	32797.99	36586.06	31030.23
	(2.17)	(1.04)	(1.92)	(3.52)	(4.27)	(3.28)	(3723.37)	(3946.79)	(1896.41)
2002	71.20	69.19	72.14	50.52	50.22	50.66	32652.24	36175.07	31008.26
	(1.75)	(0.85)	(1.14)	(2.60)	(3.35)	(2.30)	(3464.00)	(3478.60)	(1926.66)
2003	71.27	69.62	72.03	51.30	51.44	51.23	32720.04	37024.53	30711.28
	(2.01)	(1.18)	(1.87)	(2.76)	(2.65)	(2.90)	(3929.92)	(4039.95)	(1607.48)
2004	72.27	71.40	72.68	52.94	52.97	52.93	32708.17	36780.29	30807.84
	(1.61)	(1.67)	(1.45)	(2.37)	(2.30)	(2.49)	(3968.46)	(3989.92)	(2154.10)
2005	72.36	70.66	73.15	53.37	53.20	53.46	33368.8	37188.12	31586.45
	(1.97)	(0.76)	(1.86)	(2.52)	(2.63)	(2.56)	(3734.39)	(3498.25)	(2230.80)

Table 2 Regional Statistics (Cont.)

	EDUM			*EDUH*			*SECD*			*THIRD*		
YEAR	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*	*ALL*	*Urban*	*Non-Urban*
	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)	mean (s.d)
1988	41.48	46.69	39.05	6.69	11.01	4.68	27.08	27.77	26.76	63.94	69.89	61.16
	(5.85)	(3.23)	(5.20)	4.45	(5.61)	(1.60)	(5.98)	(3.99)	(6.82)	(5.22)	(4.14)	(2.74)
1989	42.85	49.96	39.54	7.08	12.22	4.69	27.40	27.03	27.57	64.18	70.79	61.10
	(5.93)	(3.72)	(3.12)	(4.91)	(5.42)	(2.06)	(6.04)	(5.24)	(6.56)	(5.65)	(5.11)	(2.16)
1990	44.07	49.95	41.34	7.24	13.06	4.53	26.70	26.42	26.84	64.90	71.09	62.02
	(5.56)	(3.02)	(4.14)	(5.14)	(5.31)	(1.67)	(5.93)	(3.87)	(6.81)	(5.24)	(4.02)	(2.49)
1991	44.82	48.36	43.17	7.16	12.39	4.73	26.22	27.03	25.85	64.86	70.67	62.15
	(4.79)	(4.74)	(3.97)	(4.94)	(5.64)	(1.74)	(5.79)	(3.48)	(6.68)	(5.02)	(4.12)	(2.43)
1992	47.31	52.27	45.00	7.88	12.79	5.59	26.25	26.68	26.06	65.67	71.72	62.86
	(5.46)	(3.32)	(4.70)	(4.78)	(5.40)	(2.05)	(5.55)	(4.29)	(6.19)	(5.48)	(4.54)	(3.09)
1993	48.56	53.11	46.45	8.63	14.06	6.11	25.93	25.68	26.05	65.98	72.50	62.95
	(4.91)	(2.02)	(4.40)	(4.69)	(4.21)	(1.98)	(4.89)	(3.67)	(5.48)	(5.28)	(3.51)	(2.35)
1994	49.83	53.99	47.90	8.38	13.28	6.10	26.07	26.02	26.10	66.13	71.98	63.40
	(4.64)	(3.63)	(3.75)	(4.66)	(5.01)	(2.07)	(4.89)	(3.70)	(5.48)	(4.97)	(3.77)	(2.45)
1995	51.01	56.08	48.65	8.90	14.27	6.39	25.80	25.58	25.90	67.01	72.88	64.27
	(5.55)	(3.08)	(4.84)	(5.15)	(5.74)	(2.15)	(4.98)	(4.79)	(5.23)	(5.25)	(4.59)	(2.67)
1996	53.54	56.97	51.95	10.19	16.37	7.31	24.83	24.00	25.22	68.02	74.46	65.01
	(5.25)	(5.40)	(4.51)	(5.30)	(4.61)	(2.28)	(5.25)	(4.06)	(5.82)	(5.75)	(4.44)	(3.29)
1997	53.55	56.90	51.98	11.53	18.66	8.20	25.03	23.62	25.70	68.11	74.61	65.08
	(5.94)	(4.29)	(6.07)	(5.75)	(4.69)	(1.74)	(5.57)	(4.01)	(6.18)	(5.87)	(4.32)	(3.57)
1998	54.22	56.98	52.94	11.76	19.40	8.20	25.23	23.52	26.03	68.09	75.19	64.79
	(5.30)	(2.43)	(5.85)	(6.56)	(6.12)	(2.41)	(5.76)	(3.96)	(6.40)	(6.07)	(4.22)	(3.31)
1999	55.69	58.15	54.55	12.56	19.70	9.23	24.56	23.40	25.11	68.67	75.55	65.47
	(4.90)	(2.44)	(5.40)	(6.22)	(5.98)	(2.34)	(5.83)	(3.90)	(6.60)	(6.03)	(4.00)	(3.63)
2000	55.63	58.65	54.22	13.16	20.88	9.57	24.34	23.01	24.97	69.13	75.80	66.02
	(5.06)	(3.47)	(5.16)	(6.65)	(6.47)	(2.18)	(6.05)	(5.00)	(6.56)	(6.19)	(5.27)	(3.61)
2001	57.76	60.58	56.44	13.88	22.58	9.82	23.80	21.72	24.78	70.35	77.24	67.15
	(5.66)	(4.28)	(5.86)	(7.11)	(6.08)	(2.12)	(5.48)	(4.22)	(5.85)	(6.14)	(4.52)	(3.64)
2002	59.33	61.61	58.27	14.32	22.89	10.32	23.68	22.38	24.29	70.32	76.67	67.36
	(4.89)	(5.54)	(4.36)	(7.41)	(7.23)	(2.48)	(5.56)	(4.28)	(6.11)	(5.74)	(4.33)	(3.45)
2003	58.77	59.93	58.23	16.13	25.37	11.82	23.49	22.57	23.92	70.53	76.73	67.64
	(4.32)	(4.81)	(4.14)	(7.80)	(7.39)	(2.33)	(5.66)	(4.81)	(6.12)	(5.74)	(5.05)	(3.22)
2004	58.13	59.19	57.65	17.25	26.87	12.76	23.70	21.93	24.52	70.63	77.29	67.53
	(4.60)	(4.96)	(4.53)	(8.11)	(7.82)	(2.18)	(5.79)	(4.93)	(6.13)	(5.90)	(4.91)	(3.06)
2005	57.47	57.97	57.25	18.98	29.15	14.25	24.17	22.37	25.01	70.50	77.01	67.47
	(4.27)	(4.40)	(4.35)	(8.36)	(7.27)	(2.57)	(5.66)	(4.73)	(6.01)	(5.79)	(4.92)	(3.00)

Source: Calculated by authors.

Note: All statistics listed in Table 2 exclude the three main offshore islands.

Table 3 Classifications of the first-order (w_{ij}^{1} =1) and the second-order spatial lag regions (w_{ij}^{2} =1)

Region	The First Spatial Lag Region (w_{ij}^{1} =1)	The Second Spatial Lag Region (w_{ij}^{2} =1)
Taipei City (Capital)	City: --- County: Taipei	City: Kee-lung, Hsin-chu County: I-lan, Tao-yuan, Hsin-chu
Kaohsiung City	City --- County: Kaohsiung	City: Chia-yi, Tai-nan County: Chia-yi, Tai-nan, Ping-tung
Kee-lung City	City: --- County: Taipei	City: Taipei, Hsin-chu County: I-lan, Tao-yuan, Hsin-chu
Hsin-chu City	City: --- County: Hsin-chu	City: Taipei, Kee-lung County: Taipei, Tao-yuan, Miao-li, Tai-chung
Tai-chung City	City: --- County: Tai-chung	City: Hsin-chu, Chia-yi County: Hsin-chu, Miao-li, Chang-hua, Nan-tou, Yun-lin, Chia-yi
Chia-yi City	City: --- County: Chia-yi	City: Kaohsiung, Tai-chung, Tai-nan County: Tai-chung, Chang-hua, Nan-tou, Yun-lin, Tai-nan
Tai-nan City	City: --- County: Tai-nan	City: Kaohsiung, Chia-yi County: Chang-hua, Yun-lin, Chia-yi, Kaohsiung, Ping-tung
Taipei County	City: Taipei, Kee-lung County: I-lan, Tao-yuan	City: Hsin-chu County: Hsin-chu
I-lan county	City: --- County: Taipei, Hua-lien	City: Taipei, Kee-lung County: ---
Tao-yuan County	City: --- County: Taipei, Hsin-chu	City: Taipei, Kee-lung, Hsin-chu County: Miao-li
Hsin-chu County	City: Hsin-chu County: Tao-yuan, Miao-li	City: Taipei, Tai-chung County: Taipei, Tai-chung
Miao-li County	City: --- County: Hsin-chu, Tai-chung	City: Hisn-chu, Tai-chung County: Tao-yuan, Chang-hua, Nan-tou
Tai-chung County	City: Tai-chung County: Miao-li, Chang-hua, Nan-tou	City: Shin-chu, Chia-yi County: Hsin-chu, Yun-lin, Chia-yi
Chang-hua County	City: --- County: Tai-chung, Nan-tou, Yun-lin	City: Tai-chung, Chia-yi, Tai-nan County: Miao-li, Chia-yi, Tai-nan

Table 3 Classifications of the first-order (w_{ij}^1=1) and the second-order spatial lag region (w_{ij}^2=1) (Cont.)

Region	The First Spatial Lag Region (w_{ij}^1=1)	The Second Spatial Lag Region (w_{ij}^2=1)
Nan-tou County	City: --- County: Tai-chung, Chang-hua, Yun-lin, Chia-yi	City: Taichung, Chia-yi County: Miao-li
Yun-lin County	City: --- County: Chang-hua, Nan-tou, Chia-yi	City: Tai-chung, Chia-yi, Tai-nan County: Tai-chung, Tai-nan
Chia-yi County	City: Chia-yi County: Nan-tou, Yun-lin, Tai-nan	City: Kaohsiung, Tai-chung, Tai-nan County: Tai-chung, Chang-hua, Kaohsiung
Tai-nan County	City: Tai-nan County: Chia-Yi, Kaohsiung	City: Kaohsiung, Chia-yi County: Chang-hua, Yun-lin, Ping-tung
Kaohsiung County	City: Kaohsiung County: Tai-nan, Ping-tung	City: Tai-nan County: Chia-yi
Ping-tung County	City: --- County: Kaohsiung, Tai-tung	City: Kaohsiung, Tai-nan County: Tai-nan, Tai-tung
Tai-tung County	City: --- County: Ping-tung, Hua-lien	City: --- County: Ping-tung, Hua-lien
Hua-lien County	City: --- County: Tai-tung, I-lan	City: --- County: Tai-tung

Note 1: Although Nan-tou County has the same borders as Kaohsiung County and Hua-lien County, the border is located in the mountains and is very difficult to reach, so we do not regard them as neighboring regions. As such, we do not regard I-lan county, Tao-yuan county, Hsin-chu county, Miao-li county and Tai-chung county as neighboring regions.

Note 2: Although Hua-lien county and Tai-tung county are neighbors, the topography of these two regions is very narrow and long, so we also regard them as the first spatial lag region and the second spatial lag region. As such, we also regard Ping-tung county and Tai-tung county as the first spatial lag region and the second spatial lag region.

Table 4 Definitions and Measurements of Regional Characteristic Variables

Variable	Definitions and Measurements
Unemployment Rate	$U_{it} = (u_{it} / A_{it}) * 100\%$
	u_{it} : Total unemployed persons in region i in year t
	A_{it} : Total labor force in region i in year t
Female Participation	$FLFP_{it} = (FEM_{it} / FEM15-64_{it}) * 100\%$
	FEM_{it} : Female labor force in region i in year t
	$FEM15-64_{it}$: Females of working age in region i in year t
Wage	$WAGE_{it} = \sum W_{it} / E_{it}$
	$\sum W_{it}$: Total salaries of the employed in region i in year t
	E_{it} : Total employed persons in region i in year t
Age	$AGE_{it} = \sum age_{it} / POP_{it}$
	$\sum age_{it}$: Sum of those above 15 years old
	POP_{it} : Population of working age in region i in year t
Low-educated Ratio	$EDUL_{it} = edul_{it} / E_{it}$
	$edul_{it}$: Employed with less than 9 years of education years
	E_{it} : Total employed persons in region i in year t
Medium-educated Ratio	$EDUM_{it} = edum_{it} / E_{it}$
	$edum_{it}$: Employed with high school diploma
	E_{it} : Total employed persons in region i in year t
Low-skilled Ratio	$PROF1_{it} = prof1_{it} / E_{it}$
	$prof1_{it}$: Numbers of manual workers in region i in year t
	E_{it} : Total employed persons in region i in year t
Medium-skilled Ratio	$PROF2_{it} = prof2_{it} / E_{it}$
	$prof2_{it}$: Numbers of assistants in region i in year t
	E_{it} : Total employed persons in region i in year t
Labor in Manufacturing Sector	$SECD_{it} = man_{it} / l_{it}$
	man_{it} : Employment in manufacturing in region i in year t
	l_{it} : Employment in region i in year t
Labor in Service Sector	$THIRD_{it} = service_{it} / l_{it}$
	$service_{it}$: Employment in service in region i in year t
	l_{it} : Employment in region i in year t

Note: i represents regions; t represents year.

Table 5 Empirical Results – All Regions (1982-2005)

Variables	IV Method			FGLS		
	1	2	3	1	2	3
Constant	-5.8110 (-1.38)	-16.0759*** (-4.46)	-9.2205** (-2.25)	-2.6538 (-0.85)	-12.0125*** (-4.11)	-5.8524* (-1.95)
Spatial-lag Unemployment Rate						
$WU1_{it}$	---	0.2587*** (3.69)	0.1476** (2.08)	---	0.2932** (5.86)	0.1771*** (3.46)
$WU2_{it}$	---	0.5576*** (7.4)	0.3490*** (4.23)	---	0.4672*** (8.73)	0.2914*** (4.87)
Regional Characteristics						
$FLFP_{it}$	-0.0397*** (-4.4)	-0.0205** (-2.32)	-0.0259*** (-2.9)	-0.0404*** (-6.1)	-0.0084 (-1.29)	-0.0216*** (-3.25)
$WAGE_{it}$	-0.00009*** (-2.68)	-0.00004*** (-2.79)	-0.00007** (-2.34)	-0.00011*** (-4.69)	-0.00004*** (-3.41)	-0.0001*** (-4.09)
AGE_{it}	0.1468** (2.31)	0.1446** (2.49)	0.1163* (1.89)	0.0807* (1.83)	0.0718* (1.72)	0.0394 (0.94)
$EDUL_{it}$	-0.0542** (-2.11)	-0.0254 (-1.04)	-0.0187 (-0.74)	-0.0524** (-2.49)	-0.0415** (-2.09)	-0.0373* (-1.85)
$EDUM_{it}$	-0.0303 (-1.19)	0.0032 (0.14)	-0.0057 (-0.23)	-0.0305 (-1.62)	-0.0101 (-0.59)	-0.0224 (-1.25)
$PROF1_{it}$	0.0805*** (3.06)	0.0781*** (3.05)	0.0525** (2.05)	0.0764*** (3.42)	0.0881*** (3.99)	0.0627*** (2.93)
$PROF2_{it}$	0.0679** (2.5)	0.0412 (1.52)	0.0330 (1.24)	0.0769*** (3.48)	0.0769*** (3.47)	0.0589*** (2.77)
$SECD_{it}$	0.0465* (1.82)	0.0527** (2.12)	0.0576** (2.34)	0.0049 (0.47)	0.0105 (1.03)	0.0119 (1.21)
$THIRD_{it}$	0.0709** (2.14)	0.1038*** (3.21)	0.0764*** (2.4)	0.0721*** (3.36)	0.0859*** (4.02)	0.0859*** (4.17)
Macro-circumstances						
DSR_t	-0.7419*** (-10.5)	---	-0.4427*** (-5.39)	-0.7354*** (-12.0)	---	-0.4260*** (-6.05)
$BUILD_t$	-0.3921*** (-6.78)	---	-0.1782*** (-2.72)	-0.3995*** (-7.51)	---	-0.1722 (-2.98)
MWA_t	0.0392*** (3.8)	---	0.0286*** (2.84)	0.0484*** (6.52)	---	0.0353*** (4.85)
Sample Size	528	528	528	528	528	528
Hausman Test	χ^2 (11)=105.20*** FE	χ^2 (10)=294.72*** FE	χ^2 (13)=91.15*** FE	---	---	---
R^2	0.6572	0.6612	0.6845	---	---	---
Log-Likelihood	---	---	---	-588.28	-579.97	-561.22
F-test	F(21,494) = 3.49***	F(21,495) = 5.30***	F(21,492) = 4.22***	---	---	---
AR(1)	---	---	---	0.3546	0.3890	0.3435
Wald χ^2	χ^2 (12) = 6720.81***	χ^2 (11) = 6821.04***	χ^2 (14) = 7316.91***	χ^2 (12)= 869.39***	χ^2 (11)= 899.60***	χ^2 (14)= 1060.82***

Note: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively.

Table 6 Empirical Results – All Regions (1988-2005)

Variables	**IV Method**			**FGLS**		
	1	**2**	**3**	**1**	**2**	**3**
Constant	-9.9354**	-15.6068***	-9.9831**	-4.5983	-14.6698***	-6.7861**
	(-2.07)	(-4.12)	(-2.35)	(-1.35)	(-4.82)	(-2.19)
Spatial-lag Unemployment Rate						
$WU1_{it}$	---	0.4938***	0.4279***	---	0.4626**	0.3299***
		(6.42)	(5.52)		(7.79)	(5.48)
$WU2_{it}$	---	0.3401***	0.2209**	---	0.3809***	0.2650***
		(4.08)	(2.5)		(5.94)	(3.96)
Regional Characteristics						
$FLFP_{it}$	0.0067	0.0097	0.0096	0.0040	0.0154*	0.0104
	(0.62)	(0.99)	(0.99)	(0.46)	(1.88)	(1.31)
$WAGE_{it}$	-0.00008***	-0.00003***	-0.00007**	-0.00012***	-0.00004***	-0.00011***
	(-2.5)	(-2.81)	(-2.38)	(-5.21)	(-3.24)	(-5.3)
AGE_{it}	0.1373**	0.1192**	0.0612	0.0252	0.1116***	0.0178
	(2.0)	(2.02)	(1.0)	(0.54)	(2.59)	(0.42)
$EDUL_{it}$	-0.0190	-0.0016	0.0026	-0.0044	0.0028	0.0010
	(-0.77)	(-0.08)	(0.12)	(-0.22)	(0.15)	(0.05)
$EDUM_{it}$	0.0048	0.0236	0.0118	0.0007	0.0266	0.0013
	(0.2)	(1.23)	(0.55)	(0.04)	(1.58)	(0.08)
$PROF1_{it}$	0.0267	0.0223	0.0063	0.0295	0.0418**	0.0144
	(1.05)	(1.01)	(0.28)	(1.43)	(2.05)	(0.74)
$PROF2_{it}$	0.0264	-0.0036	-0.0090	0.0420**	0.0432**	0.0228
	(0.98)	(-0.15)	(-0.37)	(2.07)	(2.17)	(1.2)
$SECD_{it}$	0.0629**	0.0695***	0.0737***	0.0098	0.0246**	0.0195*
	(2.34)	(2.86)	(3.09)	(0.84)	(2.21)	(1.87)
$THIRD_{it}$	0.1016***	0.1176***	0.1007***	0.0845***	0.0746***	0.0803***
	(3.0)	(3.95)	(3.35)	(3.94)	(3.65)	(4.1)
Macro-circumstances						
DSR_t	-0.4007***	---	-0.1402	-0.4568***	---	-0.1636**
	(-4.16)		(-1.57)	(-5.98)		(-2.16)
$BUILD_t$	-0.5251***	---	-0.1965***	-0.6201***	---	-0.2527***
	(-7.97)		(-2.87)	(-11.07)		(-4.07)
MWA_t	0.0506***	---	0.0312***	0.0827***	---	0.0548***
	(3.93)		(2.69)	(9.37)		(6.47)
Sample Size	396	396	396	396	396	396
Hausman Test	χ^2 (11)=22.07**	χ^2 (10)=28.10***	χ^2 (13)=28.23***	---	---	---
	FE	FE	FE			
R^2	0.8193	0.8518	0.8588	---	---	---
Log-Likelihood	---	---	---	-328.79	-310.84	-291.80
F-test	F(21,362) = 3.21***	F(21,363) = 6.96***	F(21,360) = 5.01***	---	---	---
AR(1)	---	---	---	0.4288	0.4506	0.4156
Wald χ^2	χ^2 (12) = 9472.67***	χ^2 (11) = 11663.54***	χ^2 (14) = 12156.69***	χ^2 (12)= 1133.81***	χ^2 (11)= 1220.72***	χ^2 (14)= 1478.75***

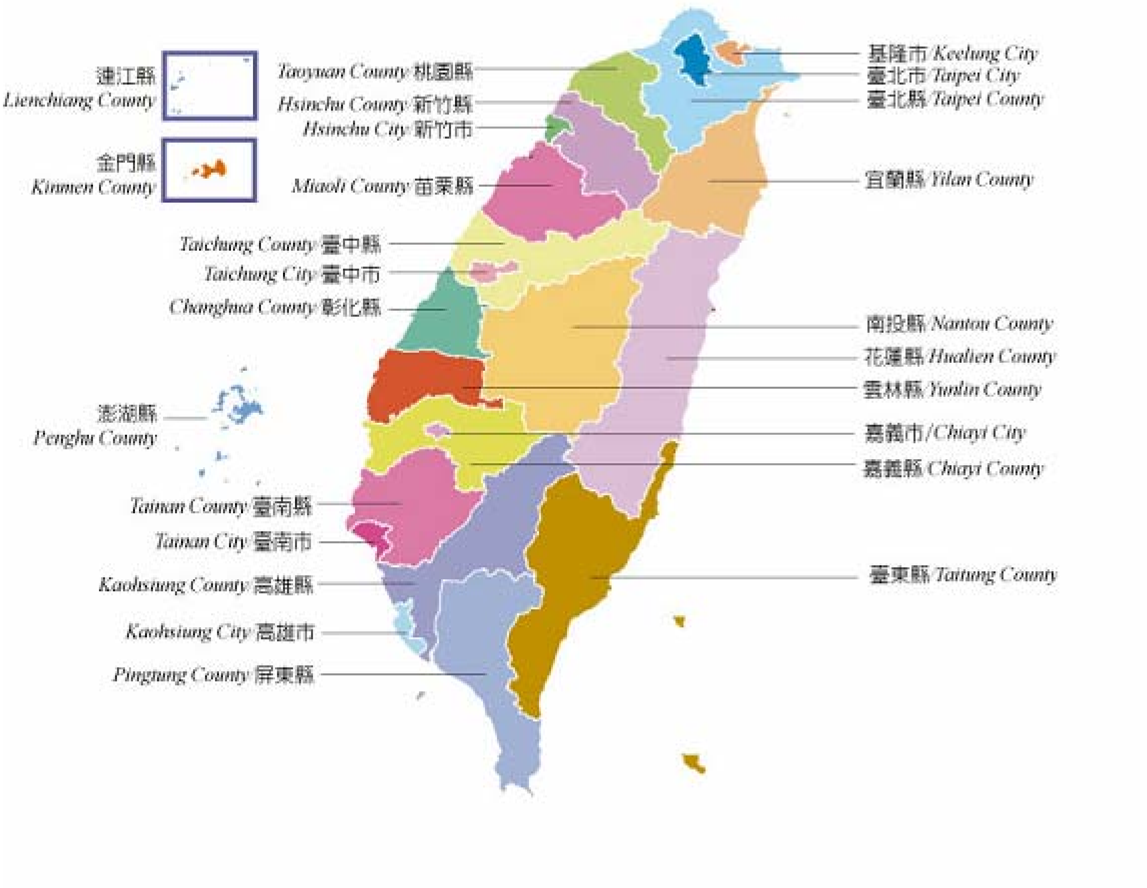
Note: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively.

Table 7 Urbanized results

Variables	1982-2005 IV	1982-2005 FGLS Urban	1982-2005 FGLS Non-Urban	1988-2005 IV	1988-2005 FGLS Urban	1988-2005 FGLS Non-Urban
Constant	-12.3443***	-0.7688	-7.2768**	-9.0613***	6.3265	-9.9446***
	(-4.59)	(-0.08)	(-2.16)	(-3.11)	(0.75)	(-2.64)
Spatial-lag Unemployment Rate						
$WU1_{it}$	0.1947***	0.0257	0.3137***	0.4028***	0.3963***	0.4024***
	(3.01)	(0.27)	(5.38)	(5.51)	(3.99)	(5.54)
$WU2_{it}$	0.2727***	0.2321	0.2931***	0.2134**	0.1896	0.2262***
	(3.61)	(1.55)	(4.95)	(2.51)	(1.46)	(3.01)
Regional Characteristic						
$FLFP_{it}$	-0.0243***	-0.0337*	-0.0133**	0.0083	0.0264	0.0033
	(-3.16)	(-1.92)	(-2.01)	(0.98)	(1.57)	(0.38)
$WAGE_{it}$	-0.00012***	-0.00009**	-0.00004	-0.00013***	-0.00007**	-0.00007**
	(-2.62)	(-2.15)	(-1.46)	(-2.48)	(-2.34)	(-2.34)
AGE_{it}	0.0922*	0.0822	0.0579	0.0675	0.1496*	0.0579
	(1.95)	(0.74)	(1.35)	(1.45)	(1.83)	(1.35)
$EDUL_{it}$	---	-0.0829**	-0.0314	---	0.0357	-0.0007
		(-2.14)	(-1.25)		(1.15)	(-0.03)
$EDUM_{it}$	---	-0.0699**	-0.0150	---	0.0013	0.0104
		(-2.06)	(-0.63)		(0.05)	(0.43)
$PROF1_{it}$	0.0690***	0.1344***	0.0657***	0.0233	0.0157	0.0451*
	(3.5)	(3.37)	(2.71)	(0.97)	(0.51)	(1.87)
$PROF2_{it}$	0.0579***	0.0770**	0.0774***	0.0219	0.0262	0.0567**
	(2.57)	(2.05)	(3.09)	(0.92)	(0.9)	(2.31)
$SECD_{it}$	0.0150	-0.0232	-0.0020	0.0234**	-0.1638**	0.0066
	(1.52)	(-0.28)	(-0.21)	(2.09)	(-2.1)	(0.61)
$THIRD_{it}$	0.1099***	0.0424	0.0599***	0.0820***	-0.1324	0.0773***
	(4.73)	(0.46)	(2.6)	(3.64)	(-1.54)	(3.44)
Urban dummy	0.7909***	---	---	0.4969**	---	---
	(4.69)			(2.55)		
Macro-circumstances						
DSR_t	-0.4650***	-0.5272***	-0.2999***	-0.1701*	-0.0930	-0.1604*
	(-5.44)	(-3.57)	(-4.04)	(-1.88)	(-0.69)	(-1.85)
$BUILD_t$	-0.2133***	-0.3378***	-0.1127**	-0.2131***	-0.3052***	-0.2181***
	(-3.2)	(-3.05)	(-1.87)	(-3.18)	(-2.87)	(-3.02)
MWA_t	0.0459***	0.0405***	0.0143*	0.0550***	0.0464***	0.0344***
	(3.62)	(2.74)	(1.69)	(3.15)	(3.32)	(2.98)
Sample Size	528	168	360	396	126	270
R^2	0.8245	---	---	0.8356	---	---
Log-Likelihood	---	-196.60	-322.86	---	-89.36	-184.42
AR(1)	---	0.2755	0.2617	---	0.2587	0.3644
Wald χ^2	χ^2 (13)= 1126.57***	χ^2 (14) = 235.50***	χ^2 (14) = 1246.30***	χ^2 (13)= 2112.83***	χ^2 (14) = 546.39***	χ^2 (14) = 1410.72***

Note: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively.

Appendix



Source: http://www.land.moi.gov.tw/translation/