# THE APPLICATION OF THE GIS TO THE GOVERNMENT'S REGULATORY IMPACT ASSESSMENT– A CASE STUDY OF THE AGRICULTURAL ZONING POLICY IN TAIWAN

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**Abstract**

Agricultural zoning is a major mean of farmland conservation and it has been a key component in policy for the prevention of urban sprawl and nonagricultural development of farmland in Taiwan. However, despite political commitments to the policy, there is currently little empirical evidence regarding the actual economic impact and effectiveness of this policy. This study adds to current knowledge by assessing the effect of agricultural zoning policy based on the Regional Planning Act which was amended in 2000 in Taiwan and using big data in combination with datasets from a management information system (MIS) and geographic information system (GIS). With the assistance of the GIS, we extracted geospatial and analytic data from map profiles along with data from a social economic dataset. By using the repeated cross-sectional zoning data at a village level and information about paddy planting areas for the first crop season in 2010 and in 2014, we applied a random effects panel regression to examine the influences of the planned zoning on cropland. Our results demonstrate that the zoning impact on paddy fields located in common agricultural zones is a significant decrease in area of about 4 hectares. However, within special agricultural districts and urban planning areas, the zoning effects seem to be positive but insignificant. This suggests the agricultural zoning policy in Taiwan is likely to discourage farmers from faming, which may prompt them to engage in alternative land use.

**Keywords:** agricultural zoning, land use, farmland protection, panel, GIS, Taiwan

## 1. INTRODUCTION

Due to significant increases in world food prices in 2007 and 2008, the global food crisis has become a phenomenon in both developing and developed nations. As a result, food security has become an important consideration. Related to this is the pressing issue of farmland conservation as well as concern over its impact on food production. In essence, as well as producing marketable agricultural commodities and related output, farmland also provides a variety of positive externalities and multi-functionalities. These include the agrarian values related to farming and environmental protection as well as anti-growth values related to safeguarding against urban sprawl (Kline and Wichelns, 1996; Brouwer and van der Heide, 2009).

This increased preoccupations with farmland conservation, the challenge of arable land loss and sustainable conversion to other kinds of land use have prompted the enactment and adoption of relevant policies in many nations such as the United States, Canada, Japan and South Korea (Duke and Lynch, 2006; Deaton and Vyn, 2010; Kline and Wichelns, 1996; Saizen et al, 2006; Schilling et al, 2014). For instance, in Canada the province of British Columbia created the Agricultural Land Reserve (ALR) to restrict subdivision and nonagricultural activities in 1973 (Eagle et al, 2014). In addition, Ontario enacted green-belt legislation in 2004 to prohibit urban development in a protected agricultural area (Vyn, 2012). In the United States, the state of Oregon established one of the earliest land use planning systems to protect prime farmland in 1974 (Jaeger et al, 2012). In Japan the Agricultural Promotion Act and National Land Use Planning Act were enacted in 1969 and 1974, respectively, and in South Korea a greenbelt policy was issued in 1971 to protect cropland from urban development.

According to Rose (1984), arable land preservation methods typically include land

use regulations, tax incentives, government acquisition of farmland, the transfer of development rights, and regulation of population distribution by controlling pubic services. In general, zoning is an important tool that is widely used in policies for permanent farmland protection (e.g. Daniels, 1999; Eagle et al, 2014). By definition, zoning regulates land use and density through two components; a text that spells out the regulations and a map of the different zoning districts (Daniels, 2010). Zoning of farmland is a specialized form of zoning that is initiated to preserve the agricultural base. The adoption of such zoning ordinances limits nearby development, assures the patterns of future land use are compatible with farming, maintains the vitality of the agricultural sector by retaining a critical mass of cropland, and ensures the continued production of agricultural commodities.

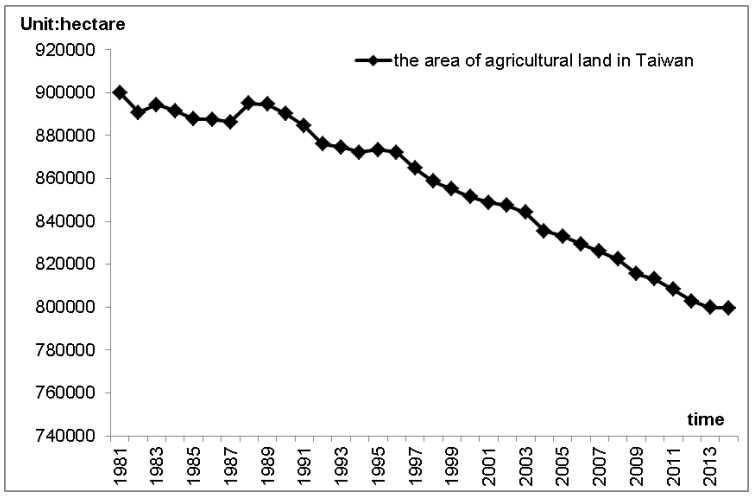
In the agricultural context, there is a sizable amount of empirical literature available on the effects of zoning on farming and non-farming activities and related conflicts (e.g. Krieger et al, 1994; Deaton and Vyn, 2010; Eagle et al, 2014; Henneberry and Barrows, 1990; Stobbe et al, 2011). There are a number of different opinions. Some studies have documented that agricultural zoning can be employed effectively to protect large tracts of farmland at a relatively low cost compared to other protection tools, such as conservation easements. For instance, the government can protect large-scale farmland by placing these areas within an effectively drafted agricultural zone so as to discourage non-farming development, for example ALR in British Columbia, the exclusive farm use districts in Oregon and exclusive agricultural zoning in Wisconsin.

On the other hand, some studies have shown disadvantages of agricultural zoning due to lack of strict enforcement and permanency in retaining open land. For example, Freilich (1999) maintains that zoning is fraught with controversy because it has tended to promote rather than discourage sprawl. Sometimes zoning district rules are easily disregarded and the land is changed, intentionally or unintentionally, to other types of land use. In addition, a change in the political atmosphere may lead to the ordinances for agricultural zoning being repealed or replaced by a significantly looser scheme.

On the other hand, landowners may be induced by the potential incentives to lobby for modification to the rules so they can transfer land from lower-valued agricultural uses to more valuable ones (Blewett and Lane, 1988; Stobbe et al, 2009). As a consequence, zoning is usually seen as a shore to medium-run tool for maintaining arable land as it is currently used (Daniels, 1999).

Concerns about the need for farmland conservation have also been confronted in Taiwan. To highlight the current state of agricultural land in Taiwan, Figure 1 depicts the trend from 1981 to 2014. It shows that the quantity of farmland has been decreasing gradually, from 900,062 hectares in 1981 to 799,611 hectares in 2014. Even though the government has taken heed of the serious loss of cropland and tried to enact policies to conserve the resource, the stock of agricultural land reached a trough in 2012 and has remained at less than 800,000 hectares. Thus the decline in farmland appears to be ongoing. Accordingly, to ensure that farming remains both economically viable and competitive, the issue of farmland protection and land use planning is both important and contentious in Taiwan.

**Figure 1. The Changing Tendency of The Agricultural Land in Taiwan**

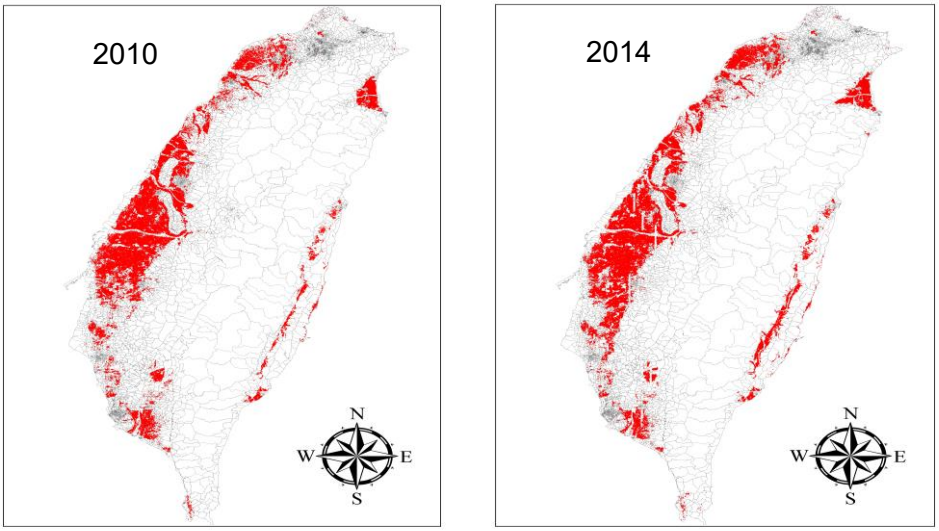



**Source: COA (2015); Authors' Calculations**

The aim of this paper is to empirically assess the zoning effects on agricultural land using the paddy field for the first crop season in Taiwan as an illustration. The zoning

scheme is based on the Regional Planning Act, which was enacted in 1974 and amended in 2000. Historically, paddy farming has been the most important industry and crop in Taiwan. The paddy field distributions for the first crop season in 2010 and 2014 are presented in **Error! Reference source not found.**. Recent advances in digital land use data and geographic information systems (GIS) have allowed us to extract analytic data from map profiles. With the software of SAS, Stata and SQL, we combined these analytic data as a panel dataset.

**Figure 2. The Paddy Field Distributions for The First Crop Season in 2010 and 2014**




**Source: COA (2015); Authors' Calculations.**

Previous studies regarding the influence of agricultural zoning are abundant. However, most of them have concentrated on the relative price effect on farmland and residences (e.g. Liu and Lynch, 2011; Zabel and Dalton, 2011), or the value of agricultural land inside and outside the urban boundaries (e.g. Knaap, 1985; Henneberry and Barrows, 1990), or the price tendencies related to distance from downtown or the greenbelt or other specific areas (e.g. Deaton and Vyn, 2010; Eagle et al, 2014). Nothing that it has been difficult to fully detail the trends in land use changes in Taiwan due to the cumbersome processing process and the lack of

appropriate datasets, it seems that relatively few studies have focused purely on the impacts of different zoning districts on farming activities and actual crop production or have evaluated the impacts on a smaller scale such as the areas of a city. For example, Kremer and DeLiberty (2011) used zoning data to assess urban Philadelphia and determine the potential for food production. Saizen et al. (2006) adapted digital land use data for the Osaka metropolitan area to examine the control effects of land use master plans.

Additionally, almost all of the existing literature on agricultural zoning in Taiwan has particular emphasized discussing land use planning and the prevalence of management strategies. The actual economic impact and effectiveness of zoning on farmland in Taiwan is not fully known at present. Probable reasons for this include the limited dataset available from the government which has a responsibility to protect farmland data because of issues related to personal property rights disclosure. Two recent examples of relevant quantitative analyses are Wu (2008) and Chang (2012).

Wu (2008) applied a land use change model with landscape metrics to simulate the change scenarios on landscape pattern under zoning in the watershed area of Keelung city in Taiwan. The study found that zoning may increase the concentration of land use in the studied areas. Using a hedonic approach, Chang (2012) revealed that population density and zoning regulations may be related to the price of farmland in Taiwan.

This study contributes to current knowledge on agricultural zoning in the following ways. Firstly, since the principal management strategies of agricultural land in Taiwan depend on zoning, it is important to clarify and assess the impact of different zoning districts on cropland. Secondly, the dataset used in this study were obtained from the government of Taiwan. The validity is reliable and thus possible measurement errors can be minimized or avoided. Thirdly, the National Land Planning Act in Taiwan was enacted in 2016. Based on the provisions, the zoning maps have to post publicly after the proclamation of the master plans' implementation. This implies that there will be

adjustments to policy including the zoning provisions and agricultural land conversion. The effects of the currently scheme must be examined in the near future. Thus, this paper may be useful from a policy perspective.

The balance of this paper is organized as follows. The Section 2 describes the model specification used for assessment. The data used in this study is introduced in Section 3, and the descriptive statistics and empirical results are discussed in Section 4. Finally, the paper concludes with a summary and a discussion of further policy implications.

## 2. MODEL SPECIFICATION

### 2.1. Panel Regression for Random Effect Model

In assessing the impact of zoning on paddy planting areas for the first crop period in 2010 and 2014, we applied a random effect panel regression model in order to examine the impact on farmland with and without specific planned zoning. The modeling framework follows Greene (2008). For the convenience of expression, let the dummy variable $D_{kit}$ denote the zoning status with the value of one, if the land area of the $i$th village has been planned as a specific *k*th zone, such as a special agricultural zone, common agricultural zone or river zone, and zero, if otherwise at year *t*.

The basic estimating equation is as follows.

$$area_{it} = \beta_k D_{kit} + \beta_{(7+j)} pop_{jit} + \beta_{11} household_{it} + \beta_{12} density_{it} + \beta_{13} agent_{it} + \beta_{14} dependecy_{it} + \beta_{15} agri_{it} + \beta_{16} ind_{it} + c_i + \varepsilon_{it}, \quad (1)$$

where the subscript $it$ indicates the village and time data for that variable were used, over $i$ villages and in the year of 2010 or 2014. The subscripts k and j represent the specific zone and the numbers of population for different age groups, where $k = 1-7$ zones and $j = 1-3$ groups, respectively. This equation contains determinants that are typically used in the analysis of zoning as it related to farmland protection and in general discussions of planning. These determinants are commonly

found in the existing literature.

In equation (1), $pop$ denotes the population amount for different age groups which are classified into three categories, that is, those aged under 14, 15 to 64, and above 65 years of age. The following measure describe the population structure in a specific village; $household$ indicates the average members per household for each village; $density$ expresses the population density per square kilometer at a village level; $agent$ refers to the numbers of qualified land administration agents registered in a particular region; the $dependecy$ indicator is measured as a percentage of population. It represents the ratio of dependents to the work force population in a given village. Dependents are defined as people aged over 65 and the work force are those aged 15 to 64. The variables $agri$ and $ind$ are the proportions of the work force who are engaged in farming and industry, respectively. The term $c_i$ is the time-invariant variable for each village. Finally, the variable $\varepsilon_{it}$ is a term for stochastic error.

### 2.2. Testing for Random Effect

Equation (1) was estimated using a random effect generalized least square (GLS) model. Based on Breusch and Pagan (1980), we employed a Lagrange multiplier (LM) test to check whether the choice of random effect panel regression is better than the ordinary least square (OLS). The null hypothesis in the LM test is that the variances across entities is zero. That is, there is no significant difference across units, or no panel effect. Under the null hypothesis, the limiting distribution of LM is a chi-square distribution with one degree of freedom. The test statistic is as below.

$$LM = \frac{\mathrm{nT}}{2(T-1)}\left[\frac{\sum_{i=1}^{n}\left[\sum_{t=1}^{T}\varepsilon_{it}\right]^2}{\sum_{i=1}^{n}\sum_{t=1}^{T}\varepsilon_{it}^2} - 1\right]. \quad (2)$$

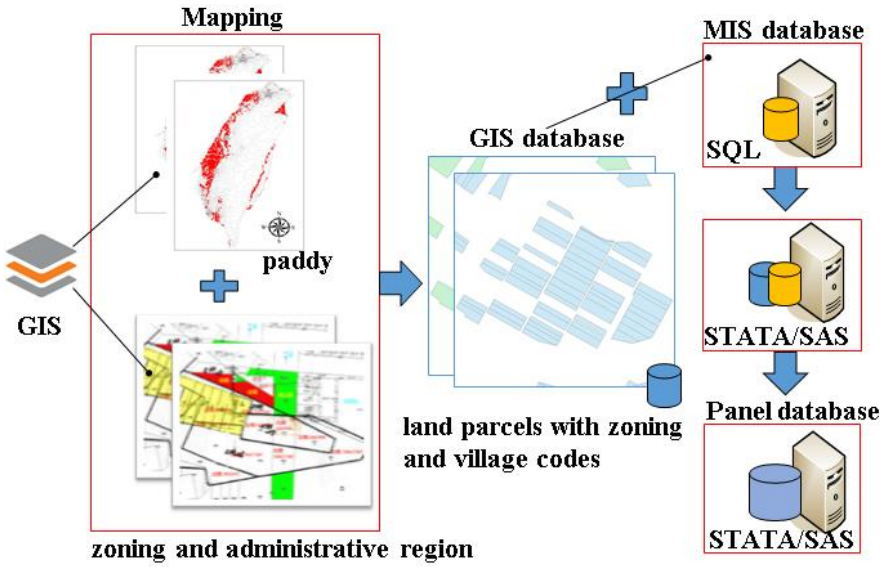
The notations of $\mathrm{n}$, $\mathrm{T}$ and $\varepsilon_{it}$ represent the number of samples, the periods of the analysis and the stochastic error term, respectively.

## 3. DATA

The dataset used for in this study includes zoning maps and the distribution of the

paddy cultivated areas recorded and released by the Council of Agriculture (COA). The COA is the highest official government department in charge of policies and monitoring for all kinds of agricultural activities in Taiwan. Thus, the data source is reliable. To construct a combined dataset from the GIS and MIS databases, we mapped the map profiles of the paddy planting areas, zoning districts, and the administrative region with village codes firstly. We then extracted the paddy land parcels with the attributes of specific zoning and village codes by GIS. Through these code attributes, we connected the social economic dataset from the MIS by SQL and SAS. Finally, we constructed a panel database and assessed by SAS and Stata. The data processing process is shown as Figure 3.

**Figure 3. Data Processing Process**




**Source: Authors' Calculations**

The whole dataset used in this study consists of data from 3,080 villages in 2010 and 3,048 villages in 2014. For the zoning distribution of the paddy fields, a summary of the village numbers, zoning parcels and the grand total areas for specific zoning is presented in Table 1. The districts of special agricultural, common agricultural, rural, industrial, forest, slope conservational, scenic, river, national park, and other utilization zones or specific-use zones under non-urban control areas as well as the

agricultural and conservational zones within the urban planning areas are included. As Table 1 shows, most paddy areas are located in the specific agricultural zones which account for about 72% of the overall rice planting areas in the non-urban control region. On average, the planting areas in the agricultural zones within the urban planning region and the common agricultural zone within non-urban control areas are almost the same. In the former, the planting areas are 12.24% of the total in 2010 and 11.26% in 2014. In the latter zone, the planting areas contributed a 12.04% share of the total in 2010 and a 12.85% share in 2014. Outside these specific zones, rice production activities are scattered across heterogeneous districts, such as scenic and river zones which have not been classified as agricultural land, in accordance with the Agricultural Development Act in Taiwan.

Meanwhile, to capture the possible impacts of social factors on farmland at a village level, we linked with a social economic dataset produced by the Department of Statistics for the Ministry of the Interior (MOI) in Taiwan as stated earlier in the data processing part. The data from the MOI was classified as population structure and village characteristics. Population structure data includes the variables of different age populations and average household size for each village. Data relating to village characteristics includes the measure of population density, the number of land agents, dependency ratio of the elderly population and the proportions of the work force who are engaged in farming and in industry.

**Table 1. Sample overview**

| Zoning districts | Village amount (unit: n) | | Zoning parcels (unit: n) | | Overall area of paddy field in specific zones (unit: hectare; %) | |
|---|---|---|---|---|---|---|
| | 2010 | 2014 | 2010 | 2014 | 2010 | 2014 |
| Agricultural | 1,243 | 1,235 | 101,974 | 111,297 | 15,112 (12.24%) | 16,832 (11.26%) |
| Conservational | 71 | 71 | 1,569 | 1,779 | 170 | 220 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | (0.14%) | (0.15%) |
| Special agricultural | 1,948 | 1,998 | 508,711 | 605,696 | 88,867 (71.99%) | 108,267 (72.4%) |
| Common agricultural | 994 | 978 | 79,928 | 98,209 | 14,856 (12.04%) | 19,222 (12.85%) |
| Rural | 1,047 | 1,034 | 8,230 | 8,409 | 220 (0.18%) | 202 (0.13%) |
| Industrial | 59 | 58 | 668 | 814 | 32 (0.03%) | 43 (0.03%) |
| Forest | 48 | 73 | 861 | 1,721 | 91 (0.07%) | 168 (0.11%) |
| Slope conservation | 361 | 381 | 20,929 | 24,045 | 2,116 (1.71%) | 2,556 (1.71%) |
| Scenic | 46 | 54 | 4,729 | 5,378 | 674 (0.55%) | 841 (0.56%) |
| Other utilization | 198 | 212 | 2,711 | 2,670 | 513 (0.42%) | 351 (0.23%) |
| National park | 8 | 11 | 361 | 322 | 42 (0.03%) | 40 (0.03%) |
| River | 340 | 382 | 9,172 | 10,929 | 741 (0.6%) | 800 (0.53%) |

**Source: Authors' calculations.**

## 4. EMPIRICAL RESULTS

As described above in the model specification section, equation (1) was estimated using a random effects GLS estimator. The results of the descriptive statistics and GLS are presented in Table 2 and Table 3 The following discussion of the results focuses on the zoning variables for the purpose of examining whether the zoning schemes and regulations on farmland in Taiwan, particularly with regard to paddy crop

farming, have effects in reality.

### 4.1. Descriptive Statistics

According to the results presented in

Table , the ratio of villages in Taiwan with paddy fields located in the special agricultural zone was 0.656 in 2010 and 0.632 in 2014, while the ratio with paddy fields located in the common agricultural zone was about 0.32 in both years. In this study the industrial and specific-use zone are grouped together as type A zone, because this is how the Taiwanese Government classifies them. The percentage of type A zone is about 0.08 in both years. The changes in the ratios for rural and river zones are small. Additionally, according to the Agricultural Development Act, the agricultural and conservational zones belong to the agricultural land zone within urban planning areas. Thus we have classified these two districts together as type B zone - the ratios are almost the same in both years.

With regard to the variables for population structure, on average, the population per village was 401, 2,040, and 344 people in 2010 and 425, 1,911 and 294 people in 2014 in the age categories under 14, between 15 and 64 and above 65, respectively. The results indicate that the number of elderly people declined over these four years whereas the number of young people increased. In both years, the average household size was approximately 3 persons per household in each village.

The population density of the village increased slightly from 2,603 to 2,606 persons per square kilometer. Comparing the average number of registered land agents per village in 2010, the amount increased from 30 to 33 agents in 2014. With reference to the dependency ratio of the elderly population in each village, the ratio declined from 20.82 in 2010 to 19.912 in 2014. This suggests that in recent years, each single work force member is responsible for almost 20 elderly people. By comparing the ratio of

those engaged in farming in both years, we saw an increase in those involved in farming while the percentage engaged in industry declined slightly.

**Table 2. Descriptive statistics.**

| Year | 2010 | | 2014 | |
|---|---|---|---|---|
| Variable | Mean | SD | Mean | SD |
| **Outcome variables** | | | | |
| Planting areas | 51.83 | 68.63 | 43.16 | 56.15 |
| **Zoning variables** | | | | |
| Special agricultural | 0.656 | 0.475 | 0.632 | 0.482 |
| Common agricultural | 0.321 | 0.467 | 0.323 | 0.468 |
| Rural | 0.339 | 0.474 | 0.340 | 0.474 |
| Type A | 0.087 | 0.281 | 0.082 | 0.274 |
| River | 0.125 | 0.331 | 0.110 | 0.313 |
| Others | 0.153 | 0.360 | 0.138 | 0.345 |
| Type B | 0.416 | 0.493 | 0.415 | 0.493 |
| **Population structure** | | | | |
| Under 14 | 401 | 424 | 425 | 436 |
| Between 15 and 64 | 2,040 | 1,694 | 1,911 | 1,591 |
| Above 65 | 344 | 186 | 294 | 145 |
| Household size | 3 | 0.387 | 3 | 0.414 |
| **Village characteristics** | | | | |
| Population density | 2,603 | 4,463 | 2,606 | 5,012 |
| Number of land agent | 30.127 | 49.744 | 33.056 | 49.752 |
| Dependency ratio | 20.820 | 7.817 | 19.912 | 8.401 |
| Farming ratio | 9.956 | 7.277 | 10.456 | 7.322 |
| Industrial ratio | 39.236 | 8.220 | 38.382 | 8.106 |

**Source: Authors' Calculations**

### 4.2. Estimation Results of the GLS Estimator

To quantify the zoning effect on farmland in Taiwan, we used the GLS estimator to assess the impacts on the paddy field and to control for other determinants that potentially effect farming. Based on the Wald test's result, the probability is 0.0039 which is less than $p \leq 0.05$. This indicates that all the coefficients in the model are different from zero. Additionally, we used an LM test to confirm the better choice between a random effect panel regression and a simple OLS. The chi-square test statistic is 391.29 and the probability is less than 0.001. Thus, we concluded that using random effects GLS regression is better.

As Table 3 shows, after controlling for population and village variables, the common agricultural zone has a negative impact of on paddy field under 1% significance level while the special agricultural zone has a positive but insignificant effect. The results indicate that the planting areas located in the common agricultural zone decreased 4.027 hectares on average, with a standard error of 1.52. The zoning impact on farmland appears to be insignificant in special agricultural, rural, type A and type B zones. In other words, within these districts, the activities of rice production are not affected by zoning and the farmers tend to continue their normal ways of farming. Surprisingly the results indicate that there has been a positive zoning effect on the paddy field in river zones. Paddy areas increase to about 5.654 hectares within the river zone ($p \leq 0.05$). This result implies that such specific zoning may potentially encourage farmers to plow the riverside land, intentionally or otherwise, since there is no rent or other associated costs that have to be paid.

The population variables, all seem statistically insignificant in regard to effect on the farmland. As to the villages properties, other than the number of land agents and the ratio of the work force engaged in industry, these variables seem to have no impact on farmland and the activities of the farmers. The results indicate that the addition of an extra agent could reduce the paddy field by 0.077 hectares on average, under 10% significance level. The results also implying that when the industrial proportion of the

work force rises, the cropland decreases by about 0.396 hectares ($p \leq 0.05$).

**Table 3. The estimation results of the GLS.**

| Variable | Coefficient | S.E. | Z | P-Value |
|---|---|---|---|---|
| **Zoning variables** | | | | |
| **Special agricultural** | **2.428** | **3.161** | **0.77** | **0.442** |
| **Common agricultural** | **-4.027** | **1.520** | **-2.65** | **0.008*****|
| **Rural** | **-0.040** | **1.102** | **-0.04** | **0.971** |
| **Type A** | **1.988** | **1.711** | **1.16** | **0.245** |
| **River** | **5.654** | **2.540** | **2.23** | **0.026**** |
| **Others** | **-0.137** | **2.391** | **-0.06** | **0.954** |
| **Type B** | **0.554** | **1.340** | **0.41** | **0.679** |
| **Population structure** | | | | |
| **Under 14** | **-0.001** | **0.002** | **-0.22** | **0.823** |
| **Between 15 and 64** | **0.000** | **0.001** | **0.04** | **0.971** |
| **Above 65** | **0.003** | **0.004** | **0.69** | **0.491** |
| **Household size** | **-1.501** | **0.934** | **-1.61** | **0.108** |
| **Village characteristics** | | | | |
| **Population density** | **0.000** | **0.000** | **-1.53** | **0.127** |
| **Number of land agent** | **-0.077** | **0.044** | **-1.75** | **0.081*** |

| | | | | |
|---|---|---|---|---|
| **Dependency ratio** | **0.027** | **0.063** | **0.43** | **0.667** |
| **Farming ratio** | **0.353** | **0.220** | **1.60** | **0.109** |
| **Industrial ratio** | **-0.396** | **0.166** | **-2.39** | **0.017**** |
| **Constant** | **99.171** | **10.859** | **9.13** | **0.000***** |

**Note: ***, **, and * indicates the significance at the 1%, 5%, and 10% level,respectively.**

**Source: Authors' calculations.**

## 5. CONCLUSIONS

Concerns for the protection of farmland and the challenges created by the loss of arable land remain major and current issues in Taiwan even though the government has put a great deal of effort into addressing them. The declining status of cropland continues and the issues of farmland conservation and land use planning are critical. Since all agricultural land was exempt from property tax after 1987, the zoning scheme is now the principal management strategy for farmland. Consequently, whether the zoning impact is effective or not is a crucial consideration for land use planning and farmland conservation.

The aim of this paper is to assess the zoning impact on agricultural land within paddy fields for the first crop season in Taiwan. As an example, we used big data in combination with datasets from a MIS and GIS. Moreover, to fill in the gaps between the zoning scheme objectives and the real economic and empirical impact on land use in Taiwan, we employed a random effect panel regression model to test zoning effects on rice production, together with a GIS mapping technique and a socio-economic dataset. To the best of our knowledge, this article is the first to provide empirical and statistical evidence regarding real farming activities and different zoning impacts in Taiwan.

Our findings have revealed that there has been a negative zoning effect of the common agricultural zone on farmland. This result is consistent with some previous

studies. Referring to the river zone, the effect is surprisingly positive. In other areas, rice production activities do not seem to be affected by different zones and the farmers operate as usual when it comes to land use. The current design of agricultural zoning has policy implications, as in its present form it may not achieve the policy targets to preserve farmland. Also, we found that the land administration agents' number may increase farmland transactions and thus decrease the areas of paddy fields. As to other socio economic variables, only the work force proportion involved in industry had significant impact on decreasing paddy field by 0.396 hectares.

Finally, the National Land Planning Act was passed in Taiwan in mid- December 2015. Adjustments to the relevant policies and land use planning may materialize in the near future. Thus, the results summarized in this paper could inform decisions regarding the future direction of zoning legislation and farmland protection at a policy level. One limitation in this study is the lack of price information concerning farmland in Taiwan. We were not able to explore the price effect with regard to zoning. Future studies could address this issue once detailed price data has been released.

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