Stigmatized versus Capitalization Effect on Farmland Prices - Application to the Agricultural Disaster Relief Program in Taiwan

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Abstract:

Literature on capitalization of agricultural policies documents that government subsidies can increase farmland values, and empirical evidence has been found in a variety of agricultural programs. However, little attention has been paid on agricultural disaster relief programs (ADRP). This paper argues that the well-documented capitalization effect of agricultural subsidies on farmland prices may not be directly applied to the ADRP because disaster shocks may also result in a negative effect on farmland values due to their stigmatized effect on the affected farmland. This paper empirically examines the effect of the ADRP payments on farmland prices using the case of Taiwan as an illustration. A unique dataset of 97,864 parcels of farmland transacted in the farmland market is used. Information of ADRP payments was drawn from the administrative profile. By estimating the fixed effect and instrumental variable fixed effect model, a negative effect of the incidence and level of the ADRP payments on farmland prices is evident. Moreover, the effect is more pronounced among farmland that is located in urban areas. This finding provides evidence that the negative stigmatized effect dominants the positive capitalization effect of the ADRP payments on farmland values, especially for farmland that is located in urban areas.

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JEL Codes: Q18, Q54

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Abstract

Literature on capitalization of agricultural policies documents that government subsidies can increase farmland values, and empirical evidence has been found in a variety of agricultural programs. However, little attention has been paid on agricultural disaster relief programs (ADRP). This paper argues that the well-documented capitalization effect of agricultural subsidies on farmland prices may not be directly applied to the ADRP because disaster shocks may also result in a negative effect on farmland values due to their stigmatized effect on the affected farmland. This paper empirically examines the effect of the ADRP payments on farmland prices using the case of Taiwan as an illustration. A unique dataset of 97,864 parcels of farmland transacted in the farmland market is used. Information of ADRP payments was drawn from the administrative profile. By estimating the fixed effect and instrumental variable fixed effect model, a negative effect of the incidence and level of the ADRP payments on farmland prices is evident. Moreover, the effect is more pronounced among farmland that is located in urban areas. This finding provides evidence that the negative stigmatized effect dominants the positive capitalization effect of the ADRP payments on farmland values, especially for farmland that is located in urban areas.

Keywords: Agricultural disaster relief program (ADRP), farmland prices, stigmatized effect, capitalization effect, Taiwan.

JEL Codes: Q15, Q18, Q54

1. Introduction

Farmland is not only the most important input of farm production but also the main asset of a farm household. The price of farmland is an important determinant of farm household wellbeing in that it represents a major proportion of farm production expenses (Barlowe 1986). There has been longstanding research interest in the determinants of farmland values. Among others, the link between agricultural subsidies and farmland values has been acknowledged. Floyd (1965), the seminal paper on this topic, provided a simple theory to demonstrate that agricultural subsidies can affect farmers' gross income and contribute to increasing returns to farmland.[1] The author also stated that different agricultural programs can impact farmland values to different extent. This strand of literature highlights the *capitalization effect* of agricultural subsidies on farmland values.

Copious empirical studies have been found to examine the capitalization effect of different agricultural support programs on farmland values. This strand of literature focused on a variety of government policies and in different countries, which includes the assessment of the impacts on farmland values from the subsidies of farm programs in the United States (e.g., Barnard *et al*., 1997; Kirwan 2009; Shaik, Helmers, Atwood 2005), in Canada (e.g., Weersink *et al*., 1999; Vyn *et al*., 2002), in Europe (e.g., Jerzy *et al*. 2014.), and in Ireland (e.g., Patton *et al*., 2008). A general consensus drawn from the existing studies is that subsidies of agricultural programs can capitalize into farmland values in some extent. However, only two studies are relevant to agricultural disaster relief programs (ADRP), to the best of our knowledge.[2] Using an individual farm household survey drawn from the Agricultural Resource and Management Survey data in the United States between 1998 and 2001, Goodwin, Mishra and Ortalo-Magne (2003) found that disaster payments significantly increased farmland prices. Using the same data between 2000 and 2006, Ifft, Kuethe and Moreheart (2015) also found a positive capitalization effect of disaster payments on cropland values.

In this study, we argue that ADRP payments should not be treated as the same way as other farm subsidies because the nature of the ADRP is quite different from other farm support programs. The purpose of the ADRP payments is to compensate the loss on farm product values after natural disaster shocks. Therefore, the effect of the ADRP payments on farmland prices is more complicated compared to the effect of other farm subsidies. When a piece of farmland was affected by disasters, it could result in a *stigmatized effect* on the affected parcels of land, which can lower its market value. The original idea of the stigmatized effect comes from the circumstance

[1] Floyd's theory has been reexamined by relaxing different assumptions and alternative policies (e.g., Alston and James 2002; Latruffe and Mouel 2009).

[2] A comprehensive review of the theory and empirical evidence regarding the capitalization effect of agricultural program subsides on farmland values can be found in Latruffe and Mouel (2009).

when a particular parcel of land or property that has been contaminated. Later on, stigmatized effect then applied to the phenomena when a loss in the value of the contaminated property (Patchin 1991). The concept of the stigmatized effect has be used to examine the impacts of a variety of environmental risks, such as pollution contaminated sites (e.g., McCluskey and Rausser 2003; Taylor, Phaneuf and Liu 2016), and flood hazards (e.g, Daniel, Florax and Rietveld 2009; Beltran, Maddison and Elliott 2018), on housing or property values. For example, Carroll *et al*. (1996) and Celine and Arthur (2014) shown that hazard facilities and the visits of natural disasters resulted in a negative impact on housing prices. With respect to the stigmatized effect related to flood hazards, Beltran, Maddison and Elliott (2018) recently conducted a meta-analysis analysis that summarized 384 point estimates from journal articles and found a 4.6% price reduction for land that is located in a 100-year inland floodplain area. In sum, most studies in this strand of literature focused on the impacts on housing prices or property values by different types of environmental risks. Relatively little has been known about farmland. Two exceptions are found. Peeters, Schreurs and Passel (2017) studied the impacts of soil contamination on farmland prices in the Belgian campine region. Wang (2016) investigated the extent to which flood risk premium can capitalize into farmland values in Lancaster county of the state of Pennsylvania in United States. The author found that a 6% reduction in market prices of farmland that is located in Federal Emergency Management Agency (FEMA) flood zones.

What is the relationship between ADRP payments and farmland prices? Two different types of theories are relevant to this issue. On the one hand, disaster shocks may generate a stigmatized effect on the damaged farmland, which can lower its market value. On the other hand, similar to other farm support programs, ADRP payments can possibly increase farmland values due to the capitalization effect. Therefore, the examination of the overall effect of the ADRP payments on farmland values becomes an empirical question.

This paper quantifies the effects of the ADRP payments on farmland prices using a case study of Taiwan as an illustration. In Taiwan, farmers can receive cash payments to compensate their loss in farm production resulted from natural disaster shocks (detailed information of the program is introduced below). A unique dataset that drawn from two different sources of administrative profiles is constructed. The primary dataset is the farmland transaction profile which consists of 97,864 parcels of farmland transacted in the farmland market between August 2012 and December 2015. We also collect information on the ADRP payments on farmland that was affected by natural disasters. This information was drawn from the administrative profile of the ADRP in Taiwan. We aggregate the ADRP payments in each township and in each month. The ADRP payments are then merged into the individual sales record of farmland by the township that each farmland is located, and the month of each transaction record. To cope with potential endogeneity problem, a standard fixed effect model and an instrumental variable fixed effect model are estimated. The severity of each typhoon that visited Taiwan in our sample period is used as the instruments for the ARDP payments. Since urban-rural disparity of farmland values has been documented in existing studies (e.g., Nilsson and Johansson 2013; Cavailhes and Wavresky 2003.), we further conduct analysis to examine regional differences in the effect of the ARDP on farmland values. Results indicate that farmland that was ever affected by disaster shocks has lower market prices by 2.43% on average compared to its counterparts of farmland that was never affected by disasters. Moreover, every NT$ 10,000 increase in ARDP payments lowers farmland prices per hectare by 0.54% on average, other things being equal. A urban-rural disparity on farmland prices with respect to disaster shocks is also evident. Compared to farmland that is located in a rural area, the negative effect of disaster shocks on farmland prices is more pronounced among farmland that is located in an urban area.

This study contributes to existing studies in several fronts. First, a sizable body of literature has documented the stigmatized effect of real estate values that are associated with a variety of environmental risks, but not much attention has been paid on farmland. This study complements this strand of literature by looking at the stigmatized effect on farmland prices resulted from disaster shocks. Second, this paper contributes to literature on the capitalization effect of agricultural subsidies on farmland values. Our study differs from Goodwin, Mishra and Ortalo-Magne (2003) and Ifft, Kuethe and Moreheart (2015) in several fronts. First, farmland prices and the amount of disaster relief payments in their study are self-reported from the respondents in the survey. In contrast, our measure of farmland prices were drawn from the sales values in the farmland market, and the amount of disaster payments was drawn from the ADRP administrative profile. Using the objective measure can avoid measurement errors. Second, the category of disaster payments documented in the ARMS data as used by Goodwin, Mishra and Ortalo-Magne (2003) includes disasters payments and market loss assistance payments. In contrast, our study only considered the ADRP payments. Third, we address the issue of urban-rural disparity with respect to the effect of the ADRP on farmland prices which has not been addressed in previous studies.

2. Background Introduction

2.1. Farmland Market in Taiwan

Until the year 2000, transactions and ownership of farmland are strictly restricted among eligible farmers. A eligible farmer must have a full-time nonfarm occupation, and cannot lease all of the self-owned farmland out. Although this strict regulation on farmland use is to make sure farmland is used for farm production, it makes the farmland market less economically competitive (Chiu 2003). In 2000, a significant policy reform in farmland markets is implemented as part of the revisited Agricultural Development Act. In this reform, non-farmers are allowed to purchase and own farmland (Council of Agriculture in Taiwan 2008). Although the amendment of Agricultural Development Act in 2000 helps to activate transactions in the farmland market, some of the farmland is then owned by part-time farmers, especial for farmland that is located in an urban or suburban area. Given that the price of residential housing is high in metropolitan areas in Taiwan, part-time farmers have bought farmland for residential or investment purpose. This results in a higher price of farmland that is located in an urban or suburban area because the values of farmland in these areas is not just determines by its contribution to farm production, but also by the option values for building residential housing (Council of Agriculture 2008).

To increase market transactions by providing more information of land and real estate market to the public, the Actual price registration system (APRS) was established in December 2011. The APRS is designed to boost transparency of transactions in the real estate markets of Taiwan. The APRS is a system for registering the actual prices of property transactions in Taiwan. All of the real estate sales through the owners, and real estate marketing agencies must be registered in the APRS within 30 days after the transaction. Registered information contains sales prices, geographical location and physical characteristics of the property. Because the APRS is a mandatory system, the responsible party will be imposed on administrative fines up to NT$ 300 thousand if he/she fails to comply with the regulations or provides false information, The registered dataset is managed by the Ministry of Interior.

Although the APRS is not exclusively for farmland, it provides an important channel to activate the farmland market. Through the mandated requirements to report detailed information of each transaction, the characteristics of farmland market becomes transparent to potential buyers, including farmers and non-farmers. The APRS is now the most important source for the government to collect information of the farmland market.

2.2. The Agricultural Disaster Relief Program in Taiwan

Agriculture production in Taiwan is vulnerable to natural disaster shocks because it is located in a semi-tropical zone. On average, 3.2 typhoons struck Taiwan annually between 1960 and 2010 (CoA, 2011). Heavy rainfall brought by typhoons cause severe damages to agriculture, especially to crop production. In 2015, the aggregated annual loss in agricultural products and facilities from natural disasters amount to

USD$ 535 million (CoA, 2015). To compensate farmers' loss, the *Agricultural Disaster Relief Program* (ADRP) was launched in 1991 and agricultural disaster payments were instituted. The ADRP is applicable to farm damages caused by typhoons, strong winds, hurricanes, heavy rainfall, low temperature, droughts, and earthquakes etc. Unlike the United States where different types of agricultural insurance programs (such as crop insurance programs) are available to farmers, the government-sponsored ADRP is the only program in Taiwan which provides compensation to farmers for their loss as a result of natural disaster shocks.

The ADRP payments are provided by the central government financial budget. The ADRP program provides lump sum cash payments to farm producers who have suffered catastrophic losses, and the cash payments are used to reimburse producers' crop and facility losses. The calculation of the crop losses is based on the following criteria. For crops which can be harvested by transferred cultivation, losses are calculated as 50% of the total production costs; for crops that cannot be transferred for cultivation, losses are calculated as total production costs; and for crops that cannot be harvested, losses are calculated as the cost of setting up the farm. Similarly, the level of ADRP payments paid for livestock farms depend on the values of production costs which vary by types of livestock. After the occurrence of a natural disaster, the officials at the local agricultural station collect information on all of the losses and report to the Council of Agriculture for final inspection and approval. Therefore, the administrative profile of the ADRP program provides precise measure of the crop and facility loss due to natural disaster shocks.

3. Data

3.1. Administrative Profile of Agricultural Disaster Relief Program

The first dataset we use is a national administrative profile for all of the farmers that received payments under the ADRP program between August 2012 and December 2015 (41 months in total). This profile was managed by the Agriculture and Food Agency of the Council of Agriculture in Taiwan. This profile documents the size of the damaged farm, total received cash payments and the township of each parcel of farmland. Moreover, it documents the name of each disaster that is associated with the payments.

Based on the information in the ADRP administrative profile, we categorize the types of disasters into two groups: typhoons and other disasters (including strong wind, heavy rainfall, low temperature, droughts, and cold frontals)[3]. In Table 1, we

[3] Due to the concern of confidentiality, the Council of Agriculture cannot release the detailed statistics for each type of disaster, except for typhoons. This is because some of the non-typhoon events only affected a small group of farms in limited number of townships. The recipients of disaster relief payments can be possibly identified if the detailed information of non-typhoon events are released.

report sample statistics for the number of visits, the number of townships that were affected by disaster shocks, total disaster payments, size of the affected farmland and average disaster payments. As reported in Table 1, there were 50 natural disasters visiting Taiwan between August 2012 and December 2015. Of which, 41 and 9 were typhoons and non-typhoons events, respectively. In total, 1,166 townships were affected by disasters and 52% of them were affected by typhoons (603/1,166=0.52). With respect to the total amount of ADRP payments, a higher level of payments was found to compensate farmers' loss due to the visits of typhoons (approximately 81% of the total ADRP payments). The average ADRP payments was NT$ 62,000/hectare and NT$ 37,000/hectare for typhoons and non-typhoons, respectively.

To provide a visual understanding of the regional disparity of the ADRP payments, we depict the distribution of the cumulated ADRP payments from August 2012 to December 2015 in each township in Figure 1. In total, there are 368 townships in Taiwan. Of which, 311 (approximately 87%) have ever affected by agricultural disasters. Among the 311 disaster-affected townships, those with darker color in Figure 1 have a higher level of the ADRP payments. It appears that townships located in middle-western areas tend to be the hot spots of receiving ADRP payments. The distribution of the ADRP payments is consistent with the fact that the middle-western areas are more flat and they are the primary agricultural production zones in Taiwan.

Two other variables related to the ADRP are defied. The first variable is a dummy variable which indicates if a specific township was affected by disaster shocks in each month. The second variable is the average monthly ADRP payments per hectare of the damaged farmland in each township between August 2012 and December 2015. These two variables are then merged into the farmland sale dataset (see more below).

3.2. Administrative Profile of the Sales Record in the Farmland Market

The primary dataset is the farmland sales dataset which was drawn from the Actual Price Registration System (APRS). The APRS is an administrative and population-based sales dataset of property transactions conducted by the Minister of Interior. The profile contains all of the real estate transactions since August 1 of 2012. Detailed information in this profile includes sales prices, date of transaction, size and other characteristics of the property and geographic location of each transacted object. To keep confidentiality, the Minister of Interior in Taiwan only releases the month of the transaction and the township of the real estate. Exact date and geographical location of the real estate is not publicly available.

We limit our sample to farmland only. Farmland is defined following the criterion defined by the Council of Agriculture. The final sample contains 97,864 parcels of farmland that was transacted in the farmland market between August 2012 and December 2015 (41 months in total).[4] For each parcel of the transacted farmland, the characteristics of farmland is documented. The value of farmland is captured by the sales price per hectare of the transacted farmland. In addition, we specify a continuous variable for the size of each parcel of the farmland. In addition, four dummy variables are specified if the farmland is located in a specific agricultural zone, regular agricultural zone, conservation zone, or other types of agricultural zones, respectively.

3.3. Characteristics of Typhoons

In addition to the administrative profile of the farmland market and the ADRP, we collect additional information to capture the severity of the disaster shocks. We define two variables that capture the severity of each typhoon: the minimum central pressure and the maximum wind speed of each typhoon. Foe each typhoon, we assign the same value of minimum central pressure and the maximum wind speed to its affected townships. These two variables were constructed and provided by the Central Weather Bureau.

The definition and sample statistics of the selected variables are reported in Table 2. In Table 2, we report the sample statistics of the selected variables in the full sample, and the two subgroups of farmland that was ever affected by the disasters and that was not. In the full sample, the average sale price is NT$ 39,680,000 per hectare of farmland. It appears that the average sales price is lower among the farmland that was ever affected by natural disasters (NT$ 39,060,000/hectare) than its counterparts of farmland that was never affected by natural disasters (NT$ 39,740,000/hectare). The average ADRP payments were NT$ 4,270/hectare in the full sample, and NT$ 45,220/hectare for the farmland that was ever affected by natural disasters.

To have snapshot evidence of the regional differences in the association between the ADRP and farmland prices, we report the sample statistics of the selected variables for urban and rural sample respectively in Table 3.[5] In our sample, approximately 26% of the farmland transaction occurred in the urban areas (24,966/97,864=0.26). It appears that the average prices per hectare are much higher for farmland that is located in an urban area than the one that is located in a rural area (NT$ 6,315 vs. NT$ 3,164). Regarding the urban-rural disparity in farmland prices, it appears that the average prices of farmland are higher for those that was never affected by disasters compared to the farmland that was ever affected by disasters.

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[4] Due to the concern of confidentiality, the specific geographical location of the land is not released. Therefore, we are not able to identify the same parcel of farmland in different transactions.

[5] The definition of rural and urban/suburban areas follows the categorization of Chang and Fu (2006); they applied a continuum score (similar to the Beale code used in the United States) to categorize Taiwan's entire 368 counties into a binary classification for rural and urban/suburban area. This approach has been a protocol of rural-urban classification in official governmental reports.

In addition to farmland prices, Tables 2 and 3 also indicates the differences in the sample statistics of other explanatory variables between the disaster-affected and non disaster-affected groups of farmland. For example, farmland that is located in a specific agricultural zone is more likely to be affected by natural disasters. This finding reveals that it is necessary to control for the differences in other explanatory variables between farmland in the two groups in order to identify the effects of the ADRP on farmland prices.

4. Econometric Framework

One econometric issue has to be addressed. The receipts of ADRP payments may be correlated with farmland prices due to some unobservable common factors. For example, the unobserved soil quality can be a driver that links these two outcomes. That is, farmland that is located in an environmentally sensitive area may have a lower market values and it may be more vulnerable to natural disaster shocks. In this case, the unobserved soil quality will result in lower farmland prices and a higher likelihood of the farm to receive ADRP payments. This problem refers to the omitted variable bias or endogeneity bias (Woodridge 2010). In this study, we apply the fixed effect (FE) model and the instrumental variable fixed effect (IV-FE) model to cope with endogeneity bias.

4.1. The Fixed Effect Model

The baseline model we estimate is the FE model for the farmland price equation. The equation that controls for the township and month fixed effects is specified as:

(1) $$\log(P_{ijt}) = \gamma \times D_{jt} + \beta' X_{ijt} + v_j + u_t + \varepsilon_{ijt}$$

where $\log(P_{ijt})$ is the logarithm of the sale prices of i^{th} parcel of farmland in township j and month t. The variable D_{jt} is related to the ADRP. In the empirical analysis, we use the likelihood of receiving ADRP payments and the amount of ADRP payments to measure the extensive and intensive margin of ADRP, respectively. X_{ijt} is a vector of explanatory variables that are related to farmland prices (i.e. different types of agricultural zones and the size of farmland, see Table 2). v_j and u_t are the fixed effect in townships and months, respectively, and ε_{ijt} is the random error. γ, β are the parameters to be estimated. In equation (1), the most interesting parameter is γ which captures the effect of the ADRP on farmland prices.

4.2. The Instrumental Variable Fixed Effect Model

In addition to the standard FE model, we also estimate the farmland prices equation using the IV-FE model.[6] The IV-FE model is a straightforward application

[6] The endogeneity issue of modeling the determinants of farmland price equation has been documented.

of the IV method to the FE framework. The IV-FE can overcome the endogeneity bias that is due to unobservable heterogeneity (Woodridge 2010). In this study, we use the minimum central pressure and the maximum wind speed of each typhoon that visited Taiwan between July 2012 and October 2016 as the IVs. The justification of using these two IVs is as follows. First, there are nine typhoons visiting Taiwan in our sample period, and 603 townships were affected by typhoons (approximately 52% out of the 1,166 townships that were ever affected by disasters). The characteristics of typhoons give enough statistical power of exogenous variation to identify the econometric model. Second, it is expected that the characteristics of typhoons and the severity of damage are directly correlated. Given that the ADRP payments are used to compensate the loss of farm production and farm facilities, the characteristics of typhoons and the likelihood and the level of ADRP payments should be directly connected as well. This argument is also supported by some of the existing studies which have pointed out that weather conditions are highly associated with agricultural disaster payments. For example, Nadolnyak and Hartarska (2012) used county-level data from four states in the southeastern United States to show that weather and climate variables explain most of the crop disaster payments. They also suggested that advancements in weather and climate forecasts could be used to determine disaster compensation.

4.3. Identification Conditions

The identification condition of the standard FE model relies on the assumption that the inclusion of the township and time fixed effects can cope with endogeneity bias as long as the source of endogeneity is due to time-invariant unobservable factors (Woodridge 2010). Taking soil quality as an example, soil quality may vary by townships and it cannot be observed by researchers. If soil quality does not change over time in a specific township, the endogeneity bias of the ADRP on farmland prices can be controlled for by the fixed effect parameter v_j.

Although the standard FE model can ease endogeneity bias, its identification condition relies on the assumption that all of the source that results in endogeneity bias must come from unobservable time-invariant factors. This assumption is somehow a strong one in that some of the unobservable factors that determine farmland prices may change over time. If any of the time-variant unobservable factor exists, the standard FE model will produce inconsistent estimation results. Let us continue with the example of soil quality for illustration. The standard FE model can produce inconsistent estimates if the unobservable soil quality changes over time in a specific township. To further avoid the endogeneity bias due to time-variant

A comprehensive review of the modeling issues in farmland equation can be found in Nickerson and Zhang (2014).

unobservable factors, we estimate the farmland prices equation using the IV-FE models. Although the IV-FE models can further control for endogeneity bias due to time-variant unobservable factors on farmland prices, it does not come for free. The validation of the IV model relies on two critical assumption. We will discuss each of them and empirically test the appropriateness of these assumptions in Section 6.

5. Empirical Results

The empirical results are presented in several tables. Table 4 presents the estimation results of the farmland price equations using the FE and IV-FE models. Tables 5 and 6 report the estimation results of the farmland price equations separately for urban and rural sample when the incidence and the level of the ADRP payments are specified as the key endogenous variable, respectively.

5.1. The Effects of Agricultural Disaster Relief Program on Farmland Prices

Table 4 reports the estimation results of the farmland prices equation using the FE and IV-FE model. In each mode, the logarithm of the farmland prices is specified as the dependent variable and the list of explanatory variables includes the likelihood or the level of the ADRP payments, different geographical zones of farmland, size of farmland, months and townships fixed effects (see Table 2). The reported stand errors of the estimates are clustered in townships. In columns (A4)-(C4), we report the estimation results when the likelihood of receiving the ADRP payments is specified as the key endogenous variable in the farmland prices equation, while columns (D4)-(F4) report the estimation results when the amount of ADRP payments is specified as the key endogenous variable in the farmland prices equation.

We begin our discussions of the results presented in Table 4 by looking at the role of the characteristics of typhoons on the likelihood and the level of the ADRP payments. As reported in columns (B4) and (E4), both of the minimum central pressure (the variable *IV_pressure*) and the maximum wind speed (the variable *IV_wind*) of typhoons are positive and statistically significant associated with the incidence and level of disaster payments. This result is not unexpected since more severe typhoons are more likely to cause large agriculture damage, and the level of the ADRP payments highly depend on the severity of farm damage. With respect to modeling issues, this result provides some evidence that the two IVs we specified are not statistically weak. They have enough statistical power to instruct the likelihood and the level of the ADRP payments.

With respect to the incidence of the ADRP on farmland prices, the estimation results of the FE model point to a significant and negative average treatment effect (ATE) on farmland prices (see column A4). Specifically, farmland that was affected by agricultural disasters has a lower market price by 3.99% on average compared to its counterparts of farmland that was never affected by agricultural disasters, *certeris paribus*. The estimation result in the IV-FE model provides a more conservative result: the estimated local average treatment effect (LATE) is -0.0243 as reported in column C3. This result indicates that, among the farmland whose price would be changed by disaster shocks (i.e. the compliers)[7], farmland prices are 2.43% lower on average among farmland that was ever affected by agricultural disasters, compared to its counterparts of farmland that was never affected by agricultural disasters, other things being equal. Although the estimation results between the FE and IV-FE cannot be directly compared[8], the difference in the magnitudes of the estimates can be partially attributed to the time-variant unobservable factors (i.e. endogeneity bias).

Similar results are found when the amount of the ADRP payments was specified as the key endogenous variable in the farmland prices equation. As reported in column D5 of Table 5, the ATE estimated by the FE model is -0.017, which indicates that every NT$ 10,000 increase in the ADRP payments on per hectare of the disaster-affected farmland decreases farmland prices by 1.17% on average compared to its counterparts of farmland that was never affected by disasters. A smaller effect is found in the estimation result of the IV-FE model. The estimated LATE pointed out that, among the farmland whose price would be changed by disaster shocks, an additional increase in NT$ 10,000 of the ADRP payments on per hectare of the disaster-affected farmland decreases farmland prices by 0.54% on average compared to farmland that was not affected by disaster shocks, other things being equal.

Our findings on the negative effect of the ADRP on farmland prices may provide some interesting implications. On the one hand, natural disasters shocks may lower farmland values due to the stigmatized effect. On the other hand, the subsidies of the disaster relief program may increase farmland values due to the capitalization effect of the ADRP payments. Given that the overall effect is negative, this result may suggest that the negative stigmatized effect dominates the positive capitalization effect on farmland values. Moreover, this evidence may possibly imply that the current level of the ADRP payments may not be high enough to compensate the public-aware stigma on farmland values resulted from disaster shocks.

5.2. Regional Disparity of the Effects

To explore the regional disparity of the ADRP effect on farmland prices, we

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[7] To interpret the local average treatment effect (LATE), Angris and Pischke (2009) categorize the sample into four groups: compliers, always-takers, never-takers, and defiers. The compliers are the group of farmland whose prices would change depending on whether it was affected by agricultural disasters and received payments or not. The IV estimates then evaluate the effects among compliers (i.e. subpopulation) but not the population. In contrast, the average treatment effect (ATE) evaluates the effects on the population.

[8] The FE model evaluates the agricultural disaster assistance effects on the full sample, while the IV-FE estimates the effect among the compliers only (see more details in Angrist and Pischke (2009).

estimate farmland price equations using the IV-FE model separately for farmland that is located in urban and rural areas, respectively. The estimation results that use the incidence of the ADRP and the associated payments as the key endogenous variable in the farmland prices equations are reported in Tables 5 and 6, respectively. Results indicate a significant and negative effect of the ADRP on farmland prices for farmland that is located in an urban area. Specifically, farmland that is located in an urban area that was ever affected by natural disasters has a lower market price by 5.13% on average compared to those never affected by disaster shocks, other things being equal (see column B5 of Table 5). With respect to the impacts of the ADRP payments on farmland prices, results in column B6 of Table 6 indicate that an additional NT$ 10,000 ADRP payments on per hectare of the affected farmland decreases farmland prices by 1.21% on average compared to farmland that was never affected by disaster shocks, *certeris paribus.* In contrast, an insignificant effect of agricultural disaster assistance on farmland prices is found for farmland that is located in an rural area.

We offer some possible expiations of our findings in urban-rural disparity below. In our sample, the average farmland prices are much higher for farmland that is located in an urban area than the one in a rural area (NT$ 63.15 million vs. NT$ 31.63 million, see Table 3). A higher average price of farmland in an urban area may reflect different purposes of land uses and different option values for future development for farmland in different regions. In Taiwan, most of the farmland that is located in an rural area are owned by full-time farmers and rural farmland is primarily used for farm production and the residency of family farm households. In contrast, a significant proportion of the farmland in an urban area is owned by part-time farmers, and it is used for building farmhouses for residency or for asset investment (Chang and Lin 2016). Given that residential housing prices are much higher in an urban, farmland in an urban area is more valuable than the one in a rural area. Another reason for the observed higher farmland prices for farmland that is in an urban area is related to option values of the farmland for future development (Plantinga and Miller 2001; Plantinga, Lubowski, Stavins 2002). For example, Plantinga and Miller (2001) developed a theory to illustrate that farmland's potential rights for future development will be reflected in the current land price. Given that farmland located in an urban area has higher option values for building farmhouses for residency, a higher value of farmland is expected for farmland in an urban area. Since the ADRP payments are only used to compensate the loss in farm production values due to disaster shocks, it is likely that the current level of agricultural disaster payments may not be high enough to overweight the negative stigmatized effect on farmland prices among farmland that is located in an urban area. Therefore, a negative effect of the ADRP payments on farmland prices for farmland located in urban areas is not unexpected.

6. Conclusions

The world has witnessed a rapid increase in extreme natural events in the last two decades, and natural disasters are expected to be more frequent in the future. To address the impacts of natural disaster shocks on farmland values is becoming more important. This study contributes to this issue by examining the effects of the disaster relief assistance on farmland prices. In contrast to other farm support programs, the effect of disaster relief programs on farmland prices can be positive or negative depending on the trade-off between a positively capitalization effect of the subsidies into farmland and a negative stigmatized effect due to disaster shocks. To the best of our knowledge, this study is among the first to address this issue.

Using a unique dataset that combines the sales records of farmland and the administrative profile of the agricultural disaster relief program in Taiwan, we estimate the farmland prices equation using the fixed effect and the instrumental variable fixed effect model to cope with endogeneity bias. Results pointed out a negative effect of the disaster relief assistance on farmland prices. Farmland that was ever affected by disasters has a lower market price by 2.43% on average compared to its counterparts of farmland that was never affected by disasters. Moreover, an increase of NT$ 10,000 in disaster relief payments lowers farmland prices per hectare by 0.54%, other things being equal. Furthermore, compared to farmland that is located in a rural area, the effect of disaster shocks on farmland prices is more pronounced among farmland that is located in an urban area.

In term of policy relevance, the evident negative effect of the disaster relief subsidies on farmland prices may point out the possibility that the current level of the cash subsidies on the disaster-affected farmland is not high enough to overweight the negative stigmatized effect resulted from disaster shocks. This result may not be too surprising since the level of the disaster relief subsidies in the current policy regime is to compensate the loss of farm production, and it does not account for non-production values of the farmland, such as the option values for future development.

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Table 1. Distribution of agricultural disaster payments in the township level

Event type	Number of disasters	Number of townships	Total payments (NT$ 100,000)	Affected areas (hectare)	Average payments (NT$ 100,000/hectare)
Typhoons	9	603	68,617	110,648	0.62
Non-typhoons#	41	563	15,946	43,446	0.37
All	50	1,166	84,564	154,094	0.55

Note: The time period of disaster shocks is between August 2012 and December 2015 (41 months). In total, there are 368 townships in Taiwan. # Including 10 strong wind (gale), 12 heavy rainfall shocks, 7 low temperature shocks, 5 droughts, and 7 cold frontals.

Table 2. Sample statistics of the selected variables.

Variable	Definition	All sample		If ever affected by disaster shocks		If never affected by disaster shocks	
		Mean	S.D	Mean	S.D	Mean	S.D
Price	Farmland price (NT$ 10,000/hectare).	3,968	6,465	3,906	8,155	3,974	6,262
Payments	Disaster payments (NT$ 10,000/hectare).	0.427	1.514	4.522	2.392	0	0
Land size	The size of the parcel of farmland (hectare).	0.296	0.625	0.291	0.655	0.297	0.622
Land_type1	If the land is located in a specific agricultural zone (=1).	0.516	0.500	0.548	0.498	0.513	0.500
Land_type2	If the land is located in a regular agricultural zone (=1).	0.254	0.435	0.228	0.419	0.256	0.437
Land_type3	If the land is located in a conservation zone (=1).	0.221	0.415	0.220	0.414	0.221	0.415
Land_type4	If the land is located in other types of agricultural zones (=1).	0.009	0.092	0.004	0.061	0.009	0.095
IV_pressure	Minimum central pressure of typhoons (hPa).	60.61	230.98	641.24	438.33	0	0
IV_wind	Maximum wind speed of typhoons (m/s).	2.86	11.09	30.24	21.74	0	0
Number of months		41		24		41	
Number of townships		291		263		290	
Parcels of farmland		97,864 (100%)		9,250 (9.5%)		81,164 (90.5%)	

Note: The sample includes all parcels of farmland transactions between August 2012 and December 2015 (41 months in total) in 291 townships in Taiwan.

Table 3. Sample statistics of the selected variables by urban and rural areas.

	Urban sample						Rural sample					
	All sample		If ever affected by disaster shocks		If never affected by disaster shocks		All		If ever affected by disaster shocks		If never affected by disaster shocks	
Variable	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Price	6,315	7,626	6,198	6,540	6,326	7,718	3,164	5,801	3,156	8,455	3,235	5,435
Payments	0.365	1.412	4.345	2.539	0.000	0.000	0.449	1.546	4.574	2.345	0.000	0.000
Land size	0.239	0.359	0.231	0.353	0.239	0.360	0.316	0.692	0.308	0.719	0.316	0.689
Land_type1	0.611	0.488	0.627	0.484	0.609	0.488	0.484	0.500	0.525	0.499	0.480	0.500
Land_type2	0.227	0.419	0.220	0.415	0.228	0.420	0.263	0.440	0.230	0.421	0.266	0.442
Land_type3	0.153	0.360	0.150	0.357	0.153	0.360	0.245	0.430	0.241	0.427	0.245	0.430
Land_type4	0.009	0.095	0.002	0.044	0.010	0.099	0.008	0.091	0.004	0.066	0.009	0.094
IV_pressure	58.22	226.48	693.43	412.97	0	0	61.43	232.49	625.95	444.36	0	0
IV_wind	2.80	11.04	33.32	20.88	0	0	2.88	11.10	29.34	21.90	0	0
Parcels of farmland	24,966 (100%)		2,096 (8.4%)		22,870 (91.6%)		72,898 (100%)		7,154 (9.8%)		65,744 (90.2%)	

Note: The sample includes all parcels of farmland transactions between August 2012 and December 2015. The detailed definition of each variable can be found in Table 2.

Table 4. Estimation results of the farmland prices equation.

	Part A: Incidence of disaster shocks on farmland price (key variable)						Part B: Disaster payments on farmland price (key variable)					
	Fixed Effect (FE)		IV-Fixed Effect (IV-FE)				Fixed Effect (FE)		IV-Fixed Effect (IV-FE)			
	(A4)		(B4)		(C4)		(D4)		(E4)		(F4)	
			First stage		Second stage				First stage		Second stage	
Variable	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
Disaster[#1]	-0.0399 **	0.0183			-0.0243 **	0.0118						
Payments							-0.0117 ***	0.0039			-0.0054 **	0.0027
IV_pressure			0.0009 ***	0.0000					0.0036 ***	0.0001		
IV_wind			0.0024 ***	0.0002					0.0203 ***	0.0015		
Land size	-0.1554 ***	0.0297	0.0016 *	0.0009	-0.1553 ***	0.0045	-0.1554 ***	0.0297	0.0057	0.0056	-0.1553 ***	0.0045
Land_type1	1.9094 ***	0.1301	0.0050	0.0060	1.9089 ***	0.0306	1.9088 ***	0.1301	-0.0549	0.0381	1.9085 ***	0.0306
Land_type2	1.6980 ***	0.1381	0.0043	0.0060	1.6976 ***	0.0309	1.6981 ***	0.1381	-0.0038	0.0385	1.6975 ***	0.0309
Land_type3	0.4973 ***	0.1246	0.0067	0.0060	0.4970 ***	0.0308	0.4977 ***	0.1247	0.0376	0.0383	0.4970 ***	0.0308
Constant	6.8001 ***	0.2105	0.0384 ***	0.0065	6.7968 ***	0.0331	6.8068 ***	0.2105	0.5180 ***	0.0412	6.7987 ***	0.0332
Control for months	Yes		Yes		Yes		Yes		Yes		Yes	
Control for townships	Yes		Yes		Yes		Yes		Yes		Yes	
Weak IV test[#2]	--		56,240				--		45,000			
Adjusted/centered R^2	0.4857		0.6671		0.4857		0.4858		0.4959		0.4857	
Parcels of farmland	97,864		97,864				97,864		97,864			

Note: The dependent variable is logarithm of the farmland price. #1: The *Disaster* is a binary indicator (=1 if any disaster shock; =0 otherwise). #2: H^0: The IVs are statistically weak. The rule-of-thumb threshold for instrument weakness is 10. Standard errors are clustered in townships. ***,**,* indicate significance at the 1%, 5% and 10% level.

Table 5. Estimation results of the incidence of receiving agricultural disaster payments on farmland prices by regions (IV-FE model).

	Urban areas				Rural areas			
	(A5) First stage		(B5) Second stage		(C5) First stage		(D5) Second stage	
Variable	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
Disaster[#1]			-0.0513 **	0.0213			-0.0174	0.0133
IV_pressure	0.0009 ***	0.0000			0.0009 ***	0.0000		
IV_wind	0.0021 ***	0.0004			0.0025 ***	0.0003		
Land size	-0.0018	0.0026	-0.2778 ***	0.0139	0.0018 **	0.0010	-0.1304 ***	0.0046
Land_type1	0.0003	0.0102	2.0295 ***	0.0542	0.0080	0.0073	1.7360 ***	0.0348
Land_type2	0.0023	0.0103	1.8999 ***	0.0547	0.0045	0.0074	1.5087 ***	0.0352
Land_type3	0.0012	0.0102	0.8089 ***	0.0542	0.0057	0.0073	0.4197 ***	0.0350
Constant	0.0306 ***	0.0108	6.8965 ***	0.5743	0.0669 ***	0.0081	6.5298 ***	0.0390
Control for months	Yes		Yes		Yes		Yes	
Control for townships	Yes		Yes		Yes		Yes	
Weak IV test [#2]	31,000				64,000			
Adjusted/centered R^2	0.7255		0.3942		0.6511		0.4926	
Parcel of farmland	24,966		24,966		72,898		72,898	

Note: The dependent variable is logarithm of the farmland prices. #1: The *Disaster* is a binary indicator (=1 if any disaster shock; =0 otherwise). #2: H0: The IVs are statistically weak. The rule-of-thumb threshold for instrument weakness is 10. Standard errors are clustered in townships. ***,**,* indicate significance at the 1%, 5% and 10% level.

Table 6. Estimation results of the agricultural disaster relief payments on farmland prices by regions (IV-FE model).

	Urban areas				Rural areas			
	(A6) First stage		(B6) Second stage		(C6) First stage		(D6) Second stage	
Variable	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
Payments			-0.0121 **	0.0050			-0.0039	0.0030
IV_pressure	0.0042 ***	0.0001			0.0034 ***	0.0001		
IV_wind	0.0053 *	0.0030			0.0253 ***	0.0018		
Land size	-0.0049	0.0177	-0.2778 ***	0.0139	0.0063	0.0060	-0.1304 ***	0.0046
Land_type1	-0.0387	0.0690	2.0291 ***	0.0542	-0.0405	0.0455	1.7357 ***	0.0348
Land_type2	-0.0363	0.0696	1.8993 ***	0.0547	0.0197	0.0460	1.5087 ***	0.0352
Land_type3	-0.0380	0.0690	0.8084 ***	0.0542	0.0424	0.0457	0.4198 ***	0.0350
Constant	0.3794 ***	0.0731	6.8995 ***	0.0575	0.8054 ***	0.0509	6.5318 ***	0.0392
Control for months	Yes		Yes		Yes		Yes	
Control for townships	Yes		Yes		Yes		Yes	
Weak IV test[#1]	12,000				33,000			
R^2	0.5120		0.3944		0.4955		0.4926	
Parcel of farmland	24,966		24,966		72,898		72,898	

Note: The dependent variable is logarithm of the farmland prices. #1: H^0: The IVs are statistically weak. The rule-of-thumb threshold for weak instruments is 10. Standard errors are clustered in townships. ***,**,* indicate significance at the 1%, 5% and 10% level.

Figure 1. Geographical distribution of agricultural disaster payments (township level).

Note: The agricultural disaster payments assigned to each township are the cumulative values between July 2012 and October 2015. There are 368 townships in Taiwan in total. The grey areas are those townships without any disaster shocks (57 townships). For the areas with marked colors (311 townships), darker colored townships are those with higher disaster payments, while those with lighter colors have lower disaster payments.