The Impact of Conservation Programs on Local Employment: A Case of the Conservation Reserve Program

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Abstract

This paper evaluates the effects of the Conservation Reserve Program (CRP) on local employment ranging from 1999 to 2005. A panel fixed effects model and an instrumental variable approach are applied to estimate the impact of the CRP on local employment for the whole nation and by region. Results indicate that while the CRP enrollment has a negative impact on agricultural employment, it has a positive impact on non-agricultural employment and the total number of jobs. These findings may moderate concern about the impact of farm conservation programs on rural economies.

Key Words: Conservation Reserve Program, Employment

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1 Introduction

Conservation-related programs, such as the Wetland Reserve Program and Grassland Reserve Program, conducted by the United States Department of Agriculture (USDA) intend to improve environmental quality by retiring active cropland. These conservation programs not only bring in environmental benefits such as reducing soil erosion and preserving forests and wetlands, but they also affect the local economy through reduction of agricultural activities on farmlands. This paper examines the impact of conservation-related programs on local employment in the U.S. using the case of the Conservation Reserve Program (CRP). The main focus of this paper is to estimate the causal relationship between the CRP enrollment and local employment. This paper provides evidence about the local economic impact of the CRP, which policy makers can consider when designing and altering conservation programs.

Due to fears about rural economic decline caused by CRP enrollment, the government sets regulations to prevent significant decreases in local employment(Sullivan et al., 2004). A 25 percent cap established by the Farm Service Agency (FSA) is one of the regulations to limit the percentage of a county's total cropland acres in the program (Stubbs, 2014). This 25 percent cap is designed to prevent counties from experiencing economic decline caused by significantly decreasing active cropland. Since agricultural production plays a substantial role in the U.S. economy (Hyberg, Dicks, and Hebert, 1991) and mainly supports the local economy in rural areas (Foster and Rosenzweig, 2004), reduction in agricultural activities may negatively affect local employment. Congress's concern about the economic cost of the CRP is evident in legislation that directs the USDA to study the potentially adverse effects of the CRP. However, previous research has not yet generated reliable nation-wide estimates of the effects of the CRP. A report published by the USDA finds that CRP enrollment decreased agricultural employment from 1986 to 1992, but that trend does not last during the 1990s (Johnson, 2005). This result, however, may be biased because the report fails to address several confounding factors that could bias the estimated effect, including land productivity and local business cycles. Also, potential selection bias of the estimates is generated from the program enrollment mechanism.

For instance, low-quality lands are more likely to be enrolled in the program. As CRP enrollment is not randomly assigned to different land parcels, the estimated impact on the local employment may be biased due to unobserved factors that affect both enrollment and local employment.

The previous literature covers a broad scope of topics related to the CRP. Researchers study the relationship between commodity prices and the CRP (Secchi and Babcock, 2007; D. R. Hellerstein and Malcolm, 2011), profile characteristics of CRP contract holders (D. Lambert and Sullivan, 2006; Chang, D. M. Lambert, and Mishra, 2008; D. M. Lambert, Sullivan, and Claassen, 2007; Lesch and Wachenheim, 2014), and potential problems caused by the CRP auction process (Vukina et al., 2008; Kirwan, Lubowski, and Roberts, 2005). Studies also investigate the impact of the CRP on land values (Lin and J Wu, 2005; JunJie Wu and Lin, 2010; Shoemaker, 1989; Kirwan, Lubowski, and Roberts, 2015), and measure the distributional impacts of the CRP among industrial sectors by applying an input-output model (Hyberg, Dicks, and Hebert, 1991).

CRP enrollment may affect local employment through declining purchases of farm inputs such as seed, fertilizer, and farm labor. Moreover, the demand for a grain elevator and processing facilities may decrease with the reduction of agricultural production activity (Sullivan et al., 2004). Based on the available data used in this paper, every 100 acres of cropland on average can provide 8 farm jobs, while on average 3,500 acres of cropland enroll in the CRP in a county per year. Thus, the number of farm jobs may decrease significantly with CRP enrollment. However, this negative effect on agricultural economic activities might be offset by the positive effect from other sectors of the rural economy (Brimlow and Roberts, 2010). For instance, croplands enrolled in the CRP can support outdoor recreation, such as hunting and bird watching, which could create more non-farm job opportunities and thus increase the total number of jobs and decrease the unemployment rate.

Previous research has not shown a causal relationship between CRP enrollment and local employment for the whole United States. Some studies focus on investigating the impact of the CRP enrollment on employment in a particular state. For example, a study focusing on North Dakota indicates that with the CRP enrollment, the employment rate delined significantly in the state(Mortensen et al., 1990). However, such a small-scale study does not provide enough evidence to generalize the results to a larger area. Other papers only show a correlation between the CRP enrollment and local employment instead of a causal relationship (Sullivan et al., 2004). Research that demonstrates the relationship between the CRP participation and local employment indicates that the effect of CRP on employment varies widely among regions. Even regions with similar acres of CRP enrollment could be affected differently due to local economic conditions (Johnson, 2005). Some research suggests that employment is strongly affected by the CRP in rural areas which are highly agriculturally dependent (Mortensen et al., 1990), however, other researchers argue that even in counties with a large share of cropland enrolled in the CRP, the effects of the CRP on local employment are small (Sullivan et al., 2004). Without successfully controlling the endogeneity problem, these studies do not generate a causal relationship between the CRP enrollment and local employment.

This paper applies two general approaches to attempt to identify the causal relationship by controlling for unobserved factors that influence both CRP enrollment and local employment. First, I attempt to control for unobserved time-invariant variables by applying a panel fixed effects model. Making use of panel data derived from the CRP enrollment bid files, I am able to use a county-level panel model to control for unobserved factors that are time-invariant within counties and time-varying differences in the dependent variables. Second, I further address the problem of endogenous enrollment by using an instrumental variable (IV) approach in addition to the panel fixed effects model. My instrument, the wildlife factor score, is from one of land's environmental qualities characteristics. It indicates the potential wildlife benefits that CRP can generate. Such environmental characteristics are part of the key qualifications for CRP enrollment. More detailed information is provided in the following sections.

Regressions are conducted for the whole US and by region to evaluate the impact of the CRP on employment for the agricultural sector, non-agricultural sector, and the whole economy. The results indicate that CRP enrollments have a negative impact on the employment for the agricultural sector, while the CRP positively affects both the non-agricultural employment and the total number of jobs for the whole economy.

The paper proceeds as follows. In the next section, I describe the CRP program. In Section 3, I explain the empirical identification strategy based on the CRP voluntary enrollment mechanism and the econometric regressions examining the effect of the CRP on employment for both the whole economy, the agricultural sector, and non-agricultural sector. Note that these regressions are conducted both for the whole nation and by US region. Section 4 provides information on data availability and data summary statistics. In the final two sections, I present and discuss the regression results and conclude the paper.

2 Background Information

The CRP, established by the Food Security Act of 1985, is the largest federally-funded private land retirement program in the United States. The program provides annual financial compensation to landowners who voluntarily join the program by signing a ten to fifteen year contract. This program intends to enhance environmental quality by paying farmers to reduce agricultural production in highly erodible and environmentally sensitive agricultural lands. As a large-scale program, the CRP generates significant environmental benefits, including increasing water and air quality, reducing soil erosion, and extending wildlife habitats. For instance, the enrollment in 1997 is estimated to have reduced 224 million tons of soil erosion (Sullivan et al., 2004).

The CRP auction mechanism works with two types of sign-up: general sign-up and continuous sign-up. I focus on the general sign-up in this paper. Each general sign-up is actually an auction process. During the bidding period, any farmer with highly erodible or environmentally sensitive land can apply for the program by indicating the parcels they wish to enroll and the annual rental payments they require. Since 1990, the Environmental Benefits Index (EBI) score has been used in the CRP enrollment process. The EBI score is assigned by the FSA to each offer and was originally constructed from the combination of erodibility and landowners' proposed rental rate. Since Sign-up 15 (the fifteenth sign-up for CRP enrollment) in 1997, the EBI score was calculated based on a candidate land parcel's score for six relevant environmental factors, such as water quality and air quality, together with one cost factor, which is the rent requested by the farmer. The EBI score rankings are unique for each parcel that applies for the program. All parcels with EBI score above the critical national cutoff are accepted while all parcels with EBI score below the cutoff are rejected.

Environmental benefits factors in the EBI score may be considered as sources for potential instrumental variables that address endogeneity problems. The wildlife factor score in the EBI score is an evaluation of the potential wildlife benefits that CRP can generate. Specifically, it is comprised of three sub-factors including wildlife habitat cover, wildlife enhancement, and wildlife priority zones. First, the wildlife habitat cover benefits indicates that FSA would give a higher score for land cover types that are more beneficial to wildlife. Also, a land parcel would achieve a higher score if the land owner take practices to enhance the wildlife benefits. In addition, if more than 51 percent of the land is located within wildlife priority zones, the application would be given a higher score. Wildlife priority zones are a set of geographic areas defined by FSA. In all, the wildlife factor score is higher if more benefits can be generated for wildlife. This score is correlated with CRP enrollment decisions made by FSA. Howeverm location in wa wildfige priority zone is unlikely to be correlated with farm profitability or employment.

3 Identification Strategy

This section describes the identification strategy used in this paper. Part A indicates the potential selection bias in the estimation process. Part B shows the panel fixed effects model. Finally, in part C, I explain the IV method.

A. Potential Selection Bias

To illustrate the potential bias in the estimation process and show my identification strategy, I start with the following county-level Ordinary Least Squares (OLS) model:

$$Local\_Employment_{kt} = \beta_1 + \beta_2 CRP_{kt-1} + \lambda Control_{kt} + \epsilon_{kt} \quad (1)$$

where the outcome variable, *Local Employment*$_{kt}$, is the employment in county k of year **t**. The outcome variables include the county-level unemployment rate and the total number of jobs for the whole economy and the number of farm jobs for the agricultural employment. The number of non-farm jobs is chosen as one of the outcome variables to examine the impact of the CRP on non-farm employment. CRP_{kt-1} is the acres of land that enrolled in the CRP in county k in year $t-1$. The coefficient, β_2, measures the marginal effect of increases in CRP enrollment on local employment in county k conditional on the control variables, $Control_{kt}$.

The control are the the county-level total cropland acres and the CRP acres coming out of the program. Previous literature show that a slippage effect of CRP enrollment reduces the environmental benefits of CRP since every 100 acres enrolled in the CRP, around 20 acres of non-cropland are converted into cropland (JunJie Wu, 2000). This slippage effect may lead to biased effects of CRP enrollment in my model. Controlling for the total cropland acres in a county may help generating unbiased estimates. I expect that the control will be positively correlated with the agricultural employment and negatively correlated with the non-agricultural employment, since an increase in cropland acres would provide more farm job opportunities. Also, I expect that the relationship between the control and the local employment for the whole economy is uncertain, as adding more croplands may increase or decrease the total number of jobs.

Estimates of causal relationship can suffer endogeneity problems caused by omitted variables. OLS estimates are biased when unobserved factors are correlated with both the dependent variable and the variable of interest. In the context of Equation (1) above, to obtain an unbiased estimate of coefficient β_2, the conditional independence assumption must be satisfied. This assumption is that the decision regarding CRP enrollment must be conditionally independent from the regression error, δ_{kt}. More specifically, this conditional independence assumption indicates that the land acres enrolled in the CRP must be uncorrelated with omitted variables in the regression error, δ_{kt}.

This independence assumption will not be satisfied in practice due to the selection bias caused by the CRP voluntary enrollment mechanism.

In the CRP enrollment mechanism, low quality land is more likely to enroll in the program because the opportunity cost of enrolling it is lower. This selection bias can be explained by the cost factor of the EBI score (Brimlow and Roberts, 2010). The cost factor is determined as follows (Kirwan, Lubowski, and Roberts, 2005):

$$Cost = w(1 - r/(NATIONAL\ MAX\ RENT)) + 10(1 - s) + Min(15, r_m - r) \quad (2)$$

where, in the first term r is the proposed annual rent rate, w is a weight parameter set at the government's discretion after all bids from across the nation are received, and NATIONAL MAX RENT is the maximum allowed soil-specific rent for all bids received from across the nation. Thus, the first component of the equation above provides a weighted average of soil rent rate, showing that a relatively lower rent (compared to the national maximum rent) requested by the farmer leads to a higher score. In the second component, s is a binary variable indicating the farmer's choice of cost sharing. A 10-point bonus will be given to farmers who do not request cost-sharing assistance. In the last term, r_m is the land parcel's soil-based maximum rent the CRP can provide and. Based on the theory; r must be less than or equal to r_m. This term gives farmers the incentive to ask rent below the maximum possible rent r_m, to get the extra points up to a 15-point limit.

This cost factor resulting in the CRP program advantages low-quality land. In general, a farmer with low-quality land is more likely to request lower rent and be more willing to give up the cost-sharing assistance option. Hence, with the cost factor, low-quality land has a higher probability of getting a higher EBI score and enrolling in the CRP program.

This selection bias caused by the cost factor of the EBI score make it challenging to determine the causal impact of CRP on the local employment. The estimate of the impact of the CRP could be unbiased if all factors that affect both CRP enrollment and local employment, such as the land quality of enrolled acres, are observed and are controlled. However, this is difficult to accomplish because of data limitations, which results in biased estimates caused by omitted variable bias.

Earlier papers show that counties with a high incidence of CRP enrollment had declining populations even before the CRP was established (Sullivan et al., 2004; Parks and Schorr, 1997; Plantinga, Alig, and Cheng, 2001). Previous research indicates that based on profit-maximizing decision of irrigation, farmers would prefer to irrigate median quality land instead of low quality land. This implies that low quality land may require less farm labor since farmer do not irrigate the low quality land (Caswell and Zilberman, 1986). In relating to CRP enrollment and local employment, it is possible that there is correlation between local employment and the CRP due to unobserved factors, not necessarily because CRP enrollment makes employment decline.

In addition, reverse causality between local employment and CRP enrollment may be another source of endogeneity problem. Not only may CRP enrollment affect local employment, but the local employment may also affect the CRP enrollment decision. If a high unemployment rate decreases labor wages in that area (Yellen, 1995), high unemployment could affect both CRP participation and CRP enrollment. First, a lower labor price might decrease landowner's incentive of applying for the program, since the cost of production is lower and farmers are more likely to keep lands for farming activities as the net profit of farming increases. On the other hand, a lower labor price may increase the possibility of enrollment. Landowners will request a lower potential rental payment if they apply to the program since farm labor is cheaper and their opportunity costs of retiring land is lower, end up with a higher score of the cost factor and a higher possibility of enrollment.

I attempt to addresses endogeneity problems and generate unbiased estimates in this paper by applying a panel fixed effects model and instrumental variable model.

B. Panel Fixed Effects Model

A panel fixed effects model can capture all time-invariant unobserved factors that cause endogeneity problems. The model is shown as follows.

$$Y_{kt} = \beta_1 + \beta_2 CRP_{kt-1} + \alpha_k + \mu_t + \lambda Control_{kt} + \epsilon_{kt} \quad (3)$$

where the outcome variable, *Local Employment*$_{kt}$, is the employment in county k of year t. The variable of interest, CRP_{kt-1}, is the acres of land that enroll in the CRP in county k in year *t-1*. The equation includes a county fixed effect, α_k, which captures all unobserved county-specific time invariant differences of the local employment that are common within counties. Thus, for instance, differences in permanent land quality and labor required for each land will not confound the CRP enrollment. This equation also includes state-by-year fixed effects, μ_{st}, absorbing time-varying differences in the dependent variables that are common across counties within a state. For instance, most government regulation and polices are at the federal and state level. With a state by year fixed effect, these policies, considering as unobserved state-specific differences, can be controlled for and do not bias the estimates. The vector $Control_{kt}$ includes other variables affecting the outcome variable. Similar to the OLS model from the last subsection, total cropland and the the CRP acres coming out of the program are used as a control. The last term, δ_{kt}, is the regression error, which contains variation due to unobserved or omitted variables. The coefficient, β_2, is the marginal effect of increases in CRP enrollment on the unemployment rate in county k conditional on same levels of total cropland acres. Note that standard errors are clustered at county level to allow within-county correlation, while keeping the assumption of zero correlation across counties as with fixed effects. Equation (4) is applied to study the impact of the CRP on local employment for the whole economy and the agricultural sector. Moreover, in the subsequent analysis, this equation is estimated separately for four separate regions (Midwest, West, South, and North), so that all parameters are allowed to vary across these regions.

However, a panel fixed effects model cannot solve all sources of endogeniety bias problem. Estimates of the coefficient may be still biased if there are time-varying unobserved factors or simultaniety that remained in the error term and affect both CRP enrollment and local employment. The IV approach is applied to capture remaining endogeneity problems.

C.Instrumental variables

The IV method has been used for a long time in economic analysis for addressing similtaneity bias and omitted variable bias encountered in OLS regression models. The IV approach allows for time-varying unobserved factors that cannot be captured by a panel fixed effects model. This method intends to find an instrumental variable that is highly correlated with the CRP enrollment decision but is not correlated with unobserved characteristics that affect outcome. Possible IV sources include geographic variation since some geographic characteristics may affect CRP enrollment but can only affect local employment through CRP participation. Based on information about the CRP enrollment mechanism given in section II, several sources of exogenous variation in the enrollment selection process can be considered as potential IVs.

I apply a panel fixed effects model with an IV to obtain a causal relationship between CRP enrollment and local employment, where CRP enrollment is instrumented by the average wildlife factor score. The average wildlife factor score is the county average of the parcel-level wildlife factor score. The model is as follows. The IV analysis is performed at the county-level. Standard errors are clustered at county level to allow within-county correlation, assuming zero correlation across counties as with fixed effects.

$$Y_{kt} = \beta_1 + \beta_2 CRP_{kt-1} + \alpha_k + \mu_{st} + \lambda Control_{kt} + \delta_{kt} \quad (4)$$

Similar to the panel fixed effects model given above, county and state-by-year fixed effects intend to capture unobserved time-invariant factors within counties and time-varying factors across counties within a state. Additional control variables including observed factors such as total cropland acres and the CRP acres coming out of the program, are intended to take care of observed factors that affect both CRP enrollment and local employment.

Two key assumptions behind the IV approach are that:

$$Cov(CRP, IV) \neq 0 \quad (5)$$

$$Cov(IV, error\_term) = 0 \quad (6)$$

Thus, IV affects CRP enrollment decision but is uncorrelated with unobserved factors influencing local employment. Conditional on the controls included in the regression, IVs can only affect local employment through CRP enrollment. If these two assumptions hold, then IV consistently identifies the average impact of the CRP enrollment attributable to the instrument. To check the satisfactions of these two assumption, first, as the wildlife factor is part of the EBI score, it is highly correlated with CRP enrollment decision. A higher wildlife factor score increases total EBI score and thus increases the possibility of enrollment. The county-average wildlife factor score would be higher if all parcels in a county have higher parcel-level wildlife factor scores. Thus, the average wildlife factor score is correlated with CRP enrollment. Second, conditional on fixed effects and other observed controls, it is unlikely that average wildlife factor is correlated with error term and can affect local employment directly without the CRP program since the average wildlife factor score is only an measurement of the geographic characteristics that affects CRP enrollment.

It is always challenging to find a good instrumental variable. Normally, the major concerns about instrument variables that they may be the weak instruments or are correlated with unobserved characteristics. The IV is considered as a weak instrument if IV is only weakly correlated with CRP enrollment. Using a weak instrument for IV approach may increase the standard error of the IV estimate and may make the estimated of the predicted impact on local employment less precise. Weak instruments may make the bias even worse than the estimates given by the OLS regression if those instruments are correlated with unobserved characteristics or omitted variables affecting the outcome. Testing for weak instruments can help avoid this problem. An informal justification indicates that the selected IV is not a weak instrument if the F-statistic reported by the first stage regression is greater than 10 (Stock and Watson, 2003). The F-statistic for the wildlife factor score is greater than 10 in the first stage regression. In addition, the Cragg-Donald Wald F statistic test is a formal weak instrument test, which provides additional information to support the selection of potential IVs.

4 Data Sources and Summary Statistics

I collect data on the unemployment rate, the number of farm jobs, the number of non-farm jobs, the total number of jobs, CRP enrollment information, EBI scores, and the total cropland acres from multiple sources to implement the analysis. This section provides data sources and reports summary statistics.

CRP Enrollment Information and Instrument Variable

The CRP acres enrollment data are from the CRP bid files provided by the FSA. In this paper, I focus on five CRP general sign-ups (15, 16, 18, 19, and 26), including CRP enrollment information. These parcel-level bids range from 1997 to 2003, and the contracts are normally implemented one year after they have been signed. Each bid file includes the information about enrollment acres for which the farmer has applied, county and state characteristics, and the application status indicating whether the application was accepted, rejected due to 25 percent limits, or rejected due to low EBI score. The independent variable, CRP enrollment, is calculated as the sum of acres accepted in each county in a year. Summary statistics in Table 1 show that Sign-up 15 has both the largest number of bids submitted (251,959) and the largest number of bids accepted (155,904). Sign-up 20 has the fewest bids submitted (56,093) (Kirwan, Lubowski, and Roberts, 2005). Also, Sign-up 26 has the fewest number of offers accepted.

The data also provide information required to calculate the EBI score, including data for the six relevant environmental factors and one cost factor. One of the components of the EBI score, the water quality score, is used as the source for an instrumental variable.

Employment Data

Farm employment is chosen as the outcome variable in the regression for studying the impact of CRP enrollment on agricultural employment. The agricultural employment data are taken from the Bureau of Economic Analysis (BEA). These county-level data are measured as the number of farm jobs. Considering that the significant impacts generated by the CRP are realised over time, to significantly capture the effects of CRP enrollment, the farm employment data are from one year after each sign-up contract is implemented. The Regional Economic Information System of BEA also provides employment data on non-farm employment, which is measured by the number of non-farm jobs at county-level. Non-farm employment is used as one of the outcome variables to examine the effect of CRP enrollment on non-agricultural employment.

I choose the total number of jobs and the unemployment rate as the outcome variables in the regression for the whole economy. The total number of jobs is the sum of the number of farm jobs and the non-farm jobs. The unemployment rate data are sourced from the Quarterly Census of Employment and Wages on Bureau of Labor Statistics. Local Area Unemployment and Statistics (LAUS) collects annual employment, unemployment, and labor force data. The unemployment rate applied in this paper is calculated based on the available data and the definition of unemployment rate, which is:

$$UnemploymentRate = (Unemployed/LaborForce) * 100 \tag{7}$$

Similar to the agricultural employment data above, both the total number of jobs data and the unemployment rate data are from one year after each sign-up contract is implemented.

Control variable

One control variable applied in the paper is county-level data on CRP acres coming out of the program due to contract expiration. Without controlling for the number of acres dropping out of the program, the estimated impact of the CRP enrollment on local employment may be underestimated. The CRP contract expiration data is available from FSA. The other control variable applied in this paper is county-level data on total cropland acres. Total cropland acres at county-level is used as a control, since variation of the total cropland acres in different counties may impact the agricultural employment and the unemployment rate. County-level total cropland acres data are not available, so I generate the measurement for total cropland by summing ten major crops planted in the U.S., including barley, cotton, corn, oats, peanuts, rye, rice, soybeans, sorghum, and wheat. This is a good proxy for total cropland since these ten types of crops already account for more than 90 percent of all field crops land. Data for planted acres of different crops are available from National Agricultural Statistics Service (NASS).

Table 2 lists the variables applied in the models. Table 3 provides the summary statistics for some important variables, which includes the mean value and the standard deviation of the variables.

5 Results

A. Relationship between the CRP and Local Employment Based on IV model

Before discussing the estimates of the CRP impact based on the IV model, several tests results related to the IV models are give in Table 4 and Table 5 and are explained as follows. Table 4 shows the endogeneity test results. The null hypothesis of the test states that the specified endogenous regressors, CRP enrollment, can be treated as exogenous. According to the test results, the null hypothesis of exogeneity is rejected (p-value=0) and the CRP enrollment needs to be treated as endogenous. A panel fixed effects model with the average water quality score as IV is implemented to study the causal relationship between CRP enrollment and local employment. Table 5 reports the results for the underidentification test and the weak instrument test. The underidentification test is given to test if the average wildlife factor score is correlated with the endogenous variable of interest, the CRP enrollment. The result shows that with a small enough chi_square p- value, the null hypothesis is rejected and the selected IV is correlated with the CRP enrollment. Whether a selected instrument is weak is tested Kleibergen-Paap rK Wald F statistic. The F statistics is 213.381, which is larger than the Stock-Yogo weak ID test critical values at 10 percent maximal IV size. Thus, the test result shows that the selected IV is not weakly correlated with the CRP enrollment.

Table 6 reports the estimated impacts of the CRP for the whole nation using the average wildlife factor score as the instrumental variable. Column (1) in Table 6 provides the estimated impact of the CRP on the number of farm jobs, the number of non-farm jobs, the total number of jobs, and the unemployment rate for the whole nation. For the whole nation, the CRP enrollment has a negative and significant impact on the number of farm jobs, while it affects the number of non-farm jobs positively and significantly. For instance, adding 100 acres (2 percent of the average number of CRP enrollment acres) into the CRP causes 2.33 farm job losses and creates 20.3 non-farm jobs, which are 0.21 percent of the average number of farm jobs and 0.11 percent of the average number of non-farm jobs respectively. As the negative impact on the number of farm jobs is offset by the increasing number of non-farm jobs, the total number of jobs is positively and significantly affected by the CRP enrollment. As shown by Table 6, an additional 100 acres of the CRP enrollment generates 18 jobs in total, which is 0.05 percent of the average total number of jobs. According to the standard deviations of the dependent and independent variables given by Table 3, if the CRP enrollment is increased by one if its own standard deviations (10,596.35), the number of farm jobs decreases by 247, which is a decrease of 75 percent of a standard deviation in the number of farm jobs. Similarly, an increase of one standard deviation in the CRP enrollment results in 9,695 more non-farm jobs, which is an increase of 10 percent of a standard deviation in the number of non-farm jobs. It also causes the total number of jobs to increase by 16,116, which is an increase of 4 percent of a standard deviation in the total number of jobs.

These results indicate that the CRP enrollment negatively affects agricultural employment, which shown by the farm job losses, while other non-farm jobs opportunities created by the program can offset this negative impact and increase the total number of jobs. Based on the estimated effect of the CRP on the total number of jobs, adding 100 acres to the CRP increases the total number of jobs by 18. However, with 100 more acres enrolled into the program, the unemployment rate slightly increases by 0.0233 percent. As the unemployment rate is defined as the percentage of total labor force that is unemployed, if the total labor force increases faster than the increase of the total number of jobs due to CRP enrollment or other unobserved factors, the unemployment rate would increase even with the total number of jobs increasing. One possible explanation of the fast changing of the labor force is as follows. As new conservation practices are installed on the croplands that enrolled in the program and provide more non-farm job opportunities, people have stronger willingness to go back to the job market and find jobs. Also, people may move into an area with more job opportunities since it is more attractive. Thus, there might be a large increase in the labor force. Examining the impact of the

CRP on labor force can provide a better understanding of the mechanism of how the program affects local employment. Based on Column (1) in Table 6, adding 100 acres into the CRP, the number of people in the labor force increases by 14.2.

As expected, cropland and acres coming out of the CRP are negatively correlated with the number of farm jobs and is positively correlated with the number of non-farm jobs. For instance, adding 100 more cropland acres into the CRP, there are 0.183 more farm jobs and 1.03 fewer non-farm jobs.

The effects of CRP may vary by region og the country. Table 6 column (2)-(5) provides the estimated impacts of the CRP on the number of farm jobs, the number of non-farm jobs, the total number of jobs, and the unemployment rate by region. The CRP and the number farm jobs are negatively correlated in the Midwest and the South, and are negatively but insignificantly correlated in the West. Adding 100 more acres of croplands into the CRP decreases the number of farm jobs by 1.96 in the Midwest and 3.58 in the South. The CPR positively and significantly affects the number of non-farm jobs and the total number of jobs in the Midwest, the South, and the West, while the impact of CRP enrollment is insignificant in the Northeast. In the Midwest, an additional 100 more acres enrolled in the CRP can create 12.7 non-farm jobs and the total number of jobs increases by 10.7. The control variables have a positive impact on farm employment and a negative impact on the non-farm employment as expected. By adding additional 100 acres of cropland to a county, as more farming activity can provide more job opportunities, the number of farm job increases by, for instance, 0.0239 in the Midwest. Results related to the control are mostly consistent across regions.

Considering the estimated impacts of CRP enrollment on local employment across different regions in the U.S., this makes intuitive sense that the estimated impacts are significant in the highly agriculturally dependent region such as the Midwest, while the effects are insignificant in the Northeast. A possible explanation is that states in the Northeast are not agriculturally dependent. For instance, New Hampshire and Maine only have around 7 percent of lands that are farmland.

In order to understand the importance of controlling for confoundedness, we explore how specification alters the esimated impact of the CRP on local employment. Table 7 presents the estimates of the CRP impact by using the full sample for the whole U.S. under the OLS model, panel fixed effects model, and the IV model.

I start my empirical analysis by providing OLS estimates of the relationship between CRP enrollment and local employment, based on equation (1). Table 7 column (1) gives the estimated impact of the CRP program on the numbler of farm jobs, the number of non-farm jobs, the total number of jobs, and the unemployment rate by using the full sample. As shown in Table 7, OLS results indicate that CRP enrollment does not have a significant impact on the number of farm jobs, the number of non-farm jobs, and the total number of jobs. For the whole economy, there appears to be a positive relationship between the CRP and the unemployment rate for the whole U.S. The control variable, total cropland acres, is negatively correlated with the number of non-farm jobs, while positively correlated with the number of farm jobs as expected. However, according to Section 3 above, the OLS estimates may be biased because of failure to control for unobserved factors that influence both CRP enrollment and local employment.

Table 7 column (2) provides estimates of the relationship between CRP enrollment and local employment from a panel fixed effects model given by Equation (4). After controlling for county fixed effects and state by year fixed effects, the results indicate the impact of CRP on the number of farm jobs, the number of non-farm jobs, the total number of jobs, and the unemployment rate are insignificant. The control, total acres of croplands, is positively correlated with the number of farm jobs and negatively correlated with the number of non-farm jobs as expected, which indicating that one more acre of cropland added to a county, the number of farm jobs is negatively affected since more farming activity can provide more job opportunities.

Table 7 column (3)(same as Table 6 column (1)) provides estimates of the relationship between CRP enrollment and local employment by appying a panel fixed effects model with IV given by Equation (5). These results were discussed in the previous subseciton.

Comparing with the estimated effects generated from the OLS model and the panel fixed effects model, the IV method generates more consistent by meaningful results.

Without controlling for unobserved time-invariant differences within counties and time-varying differences in the dependent variable, the estimated impact of the CRP on local employment appears to be biased.

Comparing the IV estimates of the CRP with the estimated impacts from the panel fixed effects model, the signs of coefficients are consistent between estimates of the two models, while the magnitude of coefficients increases and the significant level changes in the IV model results. For instance, the IV estimates show that with 100 more acres the CRP enrollment, the number of farm jobs decreases by 2.33 unit, while the number of farm jobs decreases by 0.0436 unit based on the estimates given by the panel fixed effects model. As every 100 acres of cropland on average can provide 8 farm jobs, the estimated impact of the CRP based on the IV model is more reasonable.

More detailed regressions results for the OLS model and the panel fixed effects model are given in the Appendix. Table A1 and Table A2 show the impact of the CRP on local employment for the whole nation and by region respectively.

6 Conclusion and Discussion

The CRP program distributes around 1.9 billion dollars per year to improve environmental quality. As the largest conservation program in the U.S., the CRP has been studied in a variety of ways to identify for its economic effects and environmental benefits. However, the impact of the CRP on local employment has not gained serious attention. This paper develops empirical models to evaluate the impact of the CRP on employment for the agricultural sector, non-agricultural sector, and the whole economy.

Our results indicate that the CRP program has a negative impact on agricultural employment by decreasing in the number of farm jobs. However, it also provides more non-farm job opportunities by having different conservation practices on the enrolled croplands, such as establishing wildlife habitat and permanent native grasses. The total number of jobs for the whole local economy actually increases with CRP enrollment, however, the unemployment rate for the whole economy seems also to increase in the year after an increase in CRP acres. As it is shown that the labor force increases with CRP enrollment, it is possible for the unemployment rate to increase even as the CRP increases the total number of jobs available in the economy if the labor force changes faster than the total number of jobs.

The study of the CRP in this paper demonstrates that national programs targeting environmentally sensitive acres can have an mixed effects on local economies. Hence, policy makers need to carefully consider the consequence of similar conservation programs before implementing the program (Hyberg, Dicks, and Hebert, 1991).

More work remains to be done in the study of the effects of the CRP. Finding other instrumental variables that are even more exogenous and are not correlated with unobserved factors in the error term of the regressions may improve the estimates. One possible IV is the proportion of a county's land acre that is designated as highly erodible land (HEL). HEL designation provided by the Soil Survey Geographic Database from the Natural Resources Conservation Service, which represents the geographic characteristics of the land and HEL is correlated with the CRP enrollment decision. Since HEL is an important factor that affects CRP enrollment. Land with high erodibility will have high EBI score and would have higher change enroll in the program.

Several further examinations may contribute to studying the impacts of CRP enrollment. First, besides studying the impact of the CRP on local employment, examining the impact of the program on population and income may provide a broader and more complete picture related to the conservation programs' effects on the local economy. In addition, as this paper studies the impact of the CRP on county-level economic characteristics, it would also be interesting to see how the CRP affects the economic well-being of farm households and farm size.

Table 1: CRP enrollment Information

	sign-up 15	**sign-up 16**	**sign-up 18**	**sign-up 20**	**sign-up 26**
Application	251959	126232	90306	56093	71077
Acreage applied	23275766	9504835	7100587	3490323	4148989
Offer Accepted	155904	77190	64081	40504	39376
Acreage Accepted	16072988	6600463	5541447	2704854	2147761

[1] This table provides information on CRP enrollment for 5 sign-ups used in this paper's empirical analysis, including the number of applications and acreage applied and the number of offers and acreage accepted

Table 2: Description of Variables

Variable	Level	Unit	Source
EBI score	Parcel	point	bid-file
CRP application	Parcel	acre	bid-file
CRP enrollment	County	acre	bid-file
Avg wildlife factor score	County	point	bid-file
Total Cropland	County	acres	NASS
Unemployment rate	County	percent	LAUS
Farm Employment	County	Number of farm jobs	BEA
Non-farm Employment	County	Number of farm jobs	BEA
Total number of Jobs	County	Number of jobs	BEA

[1] This table provides a quick summary about variables applied in the empirical analysis. It contains the level, unit, and data source of the variables.

Table 3: Summary statistics

Variable	Mean	Std. Dev.	N
CRP offer(acres)	79.728	123.683	592,975
CRP enrollment (acres)	3504.798	10596.35	10,149
Unemployment rate(percent)	4.997	1.986	10,149
Non-farm jobs	18295.363	47763.401	10,149
Farm jobs	1060.082	762.251	10,149
Cropland (acres)	106323	108861	10,149
Avg wildlife factor score [1]	49.88957	19.65237	10,149
Total number of jobs	31263.59	89357.08	10,149

[1] The average wildlife factor score is the county average of the parcel-level wildlife factor score.

Table 4: Endogeneity Test

	(1) Farm	(2) Non-farm	(3) Total Jobs	(4) Rate
Test statistics	334.811	32.426	24.465	100.069
Chi-sq(1) P-val	0	0	0	0

[1] This table shows the endogeneity test results. The null hypothesis of the test states that the specified endogenous regressors, CRP enrollment, can be treated as exogenous. According to the test results, the null hypothesis of exogeneity is rejected (p-value=0) and the CRP enrollment needs to be treated as endogenous.

Table 5: Test Results

Underidentification Test	
Kleibergen-Paap rk LM statistic	179.325
P-value	0
Weak Identification Test	
Kleibergen-Paap rk Wald F statistic	213.381

[1] This table reports the results for the underidentification test and the weak instrument test for the IV used in the regression analysis.

Table 6: Estimates of the Impact of CRP Enrollment-IV model (IV=Wildlife)

	(1) Full sample	(2) Northeast	(3) Midwest	(4) South	(5) West
Farm Jobs					
Enrollment	-0.0233***	0.154	-0.0196***	-0.0358***	-0.00730
	(0.00235)	(0.191)	(0.00201)	(0.00480)	(0.00924)
Out	0.0213***	-0.0854	0.0187***	0.0311***	0.00723
	(0.00208)	(0.123)	(0.00175)	(0.00378)	(0.00838)
Cropland	0.000114***	0.00326**	0.000239***	-2.13e-05	-0.000251**
	(4.07e-05)	(0.00130)	(3.72e-05)	(0.000102)	(0.000117)
Non-farm Jobs					
Enrollment	0.203***	-6.487	0.127***	0.335***	0.210**
	(0.0477)	(5.693)	(0.0385)	(0.110)	(0.0973)
Out	-0.187***	3.995	-0.117***	-0.294***	-0.201**
	(0.0422)	(3.614)	(0.0329)	(0.0945)	(0.0907)
Cropland	0.00262***	-0.0433	0.00207***	0.00314	0.00301
	(0.000576)	(0.0417)	(0.000416)	(0.00193)	(0.00185)
Total Number of Jobs					
Enrollment	0.180***	-6.333	0.107***	0.299***	0.203**
	(0.0473)	(5.626)	(0.0381)	(0.108)	(0.0960)
Out	-0.166***	3.910	-0.0982***	-0.262***	-0.194**
	(0.0418)	(3.570)	(0.0325)	(0.0937)	(0.0896)
Cropland	0.00273***	-0.0401	0.00231***	0.00312*	0.00276
	(0.000560)	(0.0412)	(0.000406)	(0.00189)	(0.00181)
Unemployment Rate					
Enrollment	0.000233***	-0.000413	0.000282***	0.000252***	2.73e-05
	(2.48e-05)	(0.00110)	(2.88e-05)	(5.04e-05)	(2.77e-05)
Out	-0.000204***	0.000251	-0.000254***	-0.000212***	-1.78e-05
	(2.19e-05)	(0.000714)	(2.49e-05)	(4.17e-05)	(2.55e-05)
Cropland	-1.70e-06***	-3.72e-05***	-1.36e-06***	-3.62e-06***	-1.01e-06
	(4.16e-07)	(7.66e-06)	(4.87e-07)	(1.02e-06)	(6.18e-07)
Labor Force					
Enrollment	0.142***	-5.365	0.116***	0.291***	-0.0701
	(0.0441)	(4.578)	(0.0335)	(0.103)	(0.0615)
Out	-0.130***	3.474	-0.105***	-0.250***	0.0555
	(0.0388)	(2.898)	(0.0285)	(0.0889)	(0.0543)
Cropland	0.000965**	-0.0882***	0.000862***	0.00119	-0.00119
	(0.000462)	(0.0339)	(0.000302)	(0.00156)	(0.000956)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[1] This table reports the estimated impact of CRP enrollment by using a pnael fixed effects model with the average wildlife factor score as the IV.
[2] It contains the CRP enrollment's effect on the number of farm jobs, the number of non-farm jobs, the total number of jobs, the unemployment rate, the labor force respectively.
[3] It also reports the regression results for the whole U.S.and by four regions.

Table 7: Estimates of the Impact of CRP Enrollment- Three models*****

	(1) OLS	(2) Panel Fixed effects	(3) IV
Farm			
Enrollment	0.00284	-0.000436	-0.0233***
	(0.00227)	(0.000272)	(0.00235)
Out	-0.00358	-0.000495	0.0213***
	(0.00242)	(0.000329)	(0.00208)
Cropland	0.000986***	0.000156***	0.000114***
	(8.67e-05)	(2.18e-05)	(4.07e-05)
Non-Farm Jobs			
Enrollment	-0.191	-0.00234	0.203***
	(0.228)	(0.00431)	(0.0477)
Out	-0.277	0.0149***	-0.187***
	(0.243)	(0.00490)	(0.0422)
Cropland	-0.0383***	-0.00148***	0.00262***
Total Number of Jobs			
Enrollment	-0.188	-0.00277	0.180***
	(0.228)	(0.00431)	(0.0473)
Out	-0.281	0.0144***	-0.166***
	(0.244)	(0.00491)	(0.0418)
Cropland	-0.0373***	-0.00132**	0.00273***
	(0.00873)	(0.000550)	(0.000560)
Rate			
Enrollment	1.67e-05***	2.47e-06	0.000233***
	(4.91e-06)	(3.14e-06)	(2.48e-05)
Out	-1.77e-05***	7.39e-06**	-0.000204***
	(5.24e-06)	(3.29e-06)	(2.19e-05)
Cropland	-5.62e-06***	6.87e-07***	-1.70e-06***
	(1.87e-07)	(2.47e-07)	(4.16e-07)
Labor			
Enrollment	-0.160	-0.00980**	0.142***
	(0.185)	(0.00495)	(0.0441)
Out	-0.269	0.0199***	-0.130***
	(0.198)	(0.00560)	(0.0388)
Cropland	-0.0322***	-4.52e-05	0.000965**
	(0.00708)	(0.000474)	(0.000462)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[1] This table compares the estimated impact of CRP enrollment by using three different models: an OLS model, a panel fixed effects model, and a panel fixed effects model with IV.

[2] It reports the CRP enrollment's effect on the number of farm jobs, the number of non-farm jobs, the total number of jobs, the unemployment rate, the labor force respectively.

[3] It shows the estimated impact of CRP for the whole U.S..

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A Appendix

Table A1: Estimates of the Impact of CRP Enrollment-OLS***

	(1) Full sample	(2) Northeast	(3) Midwest	(4) South	(5) West
Farm Jobs					
Enrollment	0.00284	0.138*	-0.00174	-0.000374	-0.00473
	(0.00227)	(0.0836)	(0.00201)	(0.00321)	(0.0107)
Out	-0.00358	-0.0624	-0.00256	-0.00185	-0.00188
	(0.00242)	(0.0601)	(0.00204)	(0.00332)	(0.0115)
Cropland	0.000986***	0.0187***	0.00106***	0.00169***	0.00118
	(8.67e-05)	(0.00104)	(6.66e-05)	(0.000137)	(0.000899)
Non-farm Jobs					
Enrollment	-0.191	-25.64*	-0.498*	-0.113	-0.276
	(0.228)	(15.44)	(0.274)	(0.390)	(0.878)
Out	-0.277	13.26	-0.261	-0.394	0.00250
	(0.243)	(11.11)	(0.278)	(0.404)	(0.938)
Cropland	-0.0383***	0.498***	-0.0350***	-0.0109	-0.0550
	(0.00871)	(0.192)	(0.00908)	(0.0166)	(0.0736)
Total Number of Jobs					
Enrollment	-0.188	-25.51*	-0.500*	-0.114	-0.280
	(0.228)	(15.46)	(0.274)	(0.391)	(0.881)
Out	-0.281	13.19	-0.263	-0.396	0.000619
	(0.244)	(11.12)	(0.278)	(0.405)	(0.941)
Cropland	-0.0373***	0.517***	-0.0339***	-0.00920	-0.0539
	(0.00873)	(0.192)	(0.00909)	(0.0167)	(0.0738)
Unemployment Rate					
Enrollment	1.67e-05***	0.000357**	1.16e-05**	2.64e-05*	-1.06e-05
	(4.91e-06)	(0.000162)	(5.86e-06)	(1.35e-05)	(1.03e-05)
Out	-1.77e-05***	-0.000222*	-2.92e-05***	-3.44e-05**	5.34e-06
	(5.24e-06)	(0.000117)	(5.95e-06)	(1.40e-05)	(1.11e-05)
Cropland	-5.62e-06***	-5.22e-06***	-4.26e-06***	-1.87e-06***	-2.00e-06**
	(1.87e-07)	(2.01e-06)	(1.95e-07)	(5.76e-07)	(8.67e-07)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A2: Estimates of the Impact of CRP Enrollment- Panel Fixed Effects***

	(1) Full sample	(2) Northeast	(3) Midwest	(4) South	(5) West
Farm Jobs					
Enrollment	-0.000436	-0.0358***	-0.000296	0.000533	-0.000593
	(0.000272)	(0.0114)	(0.000199)	(0.000647)	(0.000576)
Out	-0.000495	0.0253***	-0.000584***	-0.00187***	-0.000711
	(0.000329)	(0.00833)	(0.000177)	(0.000709)	(0.000965)
Cropland	0.000156***	0.00293***	0.000148***	1.65e-05	0.000201*
	(2.18e-05)	(0.000826)	(2.40e-05)	(3.23e-05)	(0.000106)
Non-farm Jobs					
Enrollment	-0.00234	0.0283	0.00509	-0.0254**	-0.00204
	(0.00431)	(0.236)	(0.00311)	(0.0111)	(0.0102)
Out	0.0149***	0.179	0.00462	0.0468***	0.0190*
	(0.00490)	(0.160)	(0.00523)	(0.0142)	(0.0102)
Cropland	-0.00148***	-0.0338	-0.00136**	-0.00139	-0.00337**
	(0.000551)	(0.0303)	(0.000533)	(0.00198)	(0.00152)
Total Number of Jobs					
Enrollment	-0.00277	-0.00752	0.00479	-0.0249**	-0.00263
	(0.00431)	(0.242)	(0.00308)	(0.0113)	(0.0102)
Out	0.0144***	0.204	0.00403	0.0450***	0.0183*
	(0.00491)	(0.164)	(0.00522)	(0.0144)	(0.0102)
Cropland	-0.00132**	-0.0309	-0.00122**	-0.00137	-0.00317**
	(0.000550)	(0.0303)	(0.000531)	(0.00199)	(0.00150)
Unemployment Rate					
Enrollment	2.47e-06	3.81e-06	3.03e-06	3.53e-06	3.27e-06
	(3.14e-06)	(7.95e-05)	(4.35e-06)	(9.16e-06)	(5.31e-06)
Out	7.39e-06**	3.38e-06	9.64e-06**	6.08e-06	-9.66e-07
	(3.29e-06)	(6.00e-05)	(4.56e-06)	(9.68e-06)	(5.71e-06)
Cropland	6.87e-07***	-7.27e-06	7.57e-07**	3.68e-07	1.27e-06*
	(2.47e-07)	(4.78e-06)	(3.05e-07)	(6.07e-07)	(7.64e-07)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1