Does Farmland Retirement Affect Local Employment? Evidence from the Conservation Reserve Program

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1 Introduction

Programs that improve environmental quality by retiring active croplands may entail a trade-off between environmental quality and local economic growth. Farmland retirement may generate environmental benefits such as reducing soil erosion, improving water and air quality, and enhancing wildlife habitats. However, these programs may also limit local economic activity. The debate over farmland retirement programs reveals two views. Some argue that such programs may negatively affect the local economy through a reduction of agricultural activities on farmlands and commodity production (Hyberg et al., 1991). Others argue that land retirement and conservation may provide more non-farm job opportunities and enhance economic growth (Kelly and Huo, 2013; Feather et al., 1999). This paper examines the impact of farmland retirement programs on local employment in the U.S. using data on modern implementation of the Conservation Reserve Program (CRP) from 1998-2019.

The CRP, established by the Food Security Act of 1985, is the largest federally-funded private land retirement program in the U.S.. The program provides annual financial compensation to landowners who voluntarily join the program by signing a ten to fifteen-year contract. The CRP enrollment has two mechanisms: general sign-up and continuous sign-up. Under the continuous sign-up authority, environmentally sensitive land that meets certain eligibility requirements can be enrolled in the CRP any time during continuous sign-up periods, while applications under general sign-up are subject to competitive bidding. More than 90% of enrolled croplands were under general sign-up authority during our study period.[1] The CRP can enhance environmental quality by paying farmers to reduce agricultural production in highly erodible and environmentally sensitive agricultural lands. The CRP generates significant environmental benefits by altering land use. For instance, enrollment in 1997 is estimated to have reduced 224 million tons of soil erosion per year, which is approximately 6.8 tons per CRP acre (Sullivan et al., 2004). Estimated nitrate loadings declined by 90 percent as a result of CRP in some U.S.

[1] For instance, in year 2001 32,009,793 acres of enrolled croplands were under general sign-up authority, and 1,598,661 acres of enrolled croplands were under continuous sign-up authority.

agricultural regions (Weitman, 1994).

While the CRP provides several environmental benefits, land uses changing from agricultural production to environmental conservation may have unintended negative impacts on the local economy (Beck et al., 1999). CRP enrollment might affect local employment through declining purchases of farm inputs such as seed, fertilizer, and farm labor as enrolled land is out of crop production. Moreover, the demand for grain elevators and processing facilities may decrease with the reduction of agricultural production activity (Sullivan et al., 2004). The government concerns about rural economic decline caused by CRP enrollment (Sullivan et al., 2004) and designs a 25 percent cap on enrollment per county to prevent counties from experiencing economic decline caused by significantly decreasing active croplands (Stubbs, 2014).

Any negative effect on agricultural economic activities might be offset by positive growth from other sectors of the rural economy (Brimlow et al., 2010). For instance, improved water quality and expanded wildlife habitats, can increase the quality of fishing, boating, and other water-based recreation and result in expanded opportunities for nature viewing and hunting (Feather et al., 1999; Leistritz et al., 2002; Bangsund et al., 2004; Young and Osborn, 1990). A positive relationship between natural amenities and rural development is well established in the previous work (Wirtz et al., 2002; Goetz and Rupasingha, 2002), and the CRP may also promote residential land-use growth rate (Johnson and Maxwell, 2001). Thus, CRP enrollment might bring in more non-farm job opportunities as it improves environmental quality (Sullivan et al., 2004). If alternative economic activities generated by the CRP can be large enough to offset employment loss in the agricultural sector, local economies may not be negatively affected by the program.

Early research that focused on the economic impact of the CRP were mainly conducted in the late 1980s to the early 1990s used input-output models (Hyberg et al., 1991; Broomhall and Johnson, 1990; Martin et al., 1988; Mortensen et al., 1990; Siegel and Johnson, 1991). Findings from these studies show that the CRP harms income, jobs, and population in rural communities. For instance, Mortensen et al. (1990) find that CRP enrollment led to a significant decline in the employment rate in North Dakota. Sullivan

et al. (2004) used matching methods to study the short-run and long-run impact of the CRP for the first 15 years of the program (1985 to 2000) in counties largely located in the Great Plains. Those results from that and a follow up study (Brown et al., 2018) showed that the initial negative impact of the CRP on employment growth diminished in the long run.

Previous research on this subject has two main limitations. First, these studies were limited to narrow geographies. Even the most expansive study (Sullivan et al., 2004) focused largely on the Great Plains, an area most likely to be affected by the CRP. However, the effect of a given acres enrolled in the CRP on local economic development may vary by region due to heterogeneous local economic conditions (Johnson, 2005). While Sullivan et al. (2004) find the CRP would have negligible effect on local employment in the long run in their study area, other researchers argue that employment is strongly affected by the CRP in rural areas that are highly agriculturally dependent (Mortensen et al., 1990). This paper expands the study region to the entire contiguous U.S. and explores heterogeneity in the impacts of CRP enrollment in different regions, bringing new insights to this topic.

Second, these studies used data from early days of the CRP, but enrollment criteria and practices have experienced two types of significant changes since the late 1990s such that those findings may not generalize to a more recent period of time. While the primary goal of the CRP in the first few years was to reduce soil erosion, an Environmental Benefit Index (EBI) score was created in the 1990 Farm Bill for the CRP general enrollment process. Since 1997, the EBI score has accounted for six potential environmental benefits and the rental payment as cost (Conservation Reserve Program Sign-Up Fact Sheet, 2013).[2] The adoption of the EBI score in CRP enrollment emphasizes the importance of other potential environmental benefits enrolled land could generate in addition to reduction in soil erosion, so a higher fraction of enrolled land may provide high-value of ecosystem services and stimulate non-farm job opportunities related to recreation. Furthermore,

[2]These six environmental benefits associated with an applied parcel include benefits to wildlife habitat, water quality, the farm itself from reduced erosion to air quality, and benefits that will last beyond the contract period

cumulative enrollment has varied widely over time with the national budget set by the Farm Bills and the changes in agricultural commodity prices. After the adoption of the new EBI design in 1997, CRP enrollment started to increase in 2000 and reached its maximum acreage of 36.77 million acres in 2007; since then, the amount of CRP acreage has declined every year, due largely to high commodity prices 2007 -2017 (Hellerstein et al., 2011) (Figure A.1). The 2018 Farm Bill lowered the maximum rental payments for the program and increased the acreage enrollment cap by 3 million acres; the net effect on total enrolled acres was negative. Wu and Weber (2012) expressed concern about declining economic and environmental benefits associated with reduced CRP enrollment; changes in total enrollment may alter the marginal economic impact of new CRP acres.

Thus, it is valuable to explore the impacts of the CRP on local labor markets using updated data to examine if the earlier findings still hold, given that both the enrollment and the program have experienced significant change since the late 1990s. This paper focuses on periods after the adoption of the new EBI design and utilizes data from 1998 to 2019 to study the impacts of CRP enrollment on local employment for the entire U.S. to generate a nation-wide analysis of the effects of farmland retirement and explore the regional heterogeneity of the CRP's impact. A panel fixed-effects model is applied to identify the causal relationship between CRP enrollment and local employment for the agricultural sector, the non-agricultural sector, and the whole economy.

We find CRP enrollment has a negative and significant impact on employment for the agricultural sectors, but impacts on farm employment vary across regions. The CRP does not affect farm jobs in the Midwest, where CRP enrollment is high but per acre farm labor required is low. The negative impact on farm jobs is mainly seen in the West and Northeast. Moreover, it seems that CRP enrollment may lead to rural development by improving natural amenities and attracting tourists, residents, and businesses, as evidenced by a rise in non-farm jobs in recreation, food, and lodging services. However, these industries only make up a small portion of the economy, and the CRP does not have a significant impact on non-agricultural or total employment for the nation or by region. As a robustness check, we utilize the approach of Lewbel (2012) to examine the

impacts of the CRP using a panel fixed effects model with instrumental variables (IV). The robustness check results align with findings from a panel fixed effects model.

2 Empirical Strategy

This paper estimates the effects of CRP enrollment on local employment at the county-level. To establish a causal relationship between CRP enrollment and local employment in an experiment, we would ideally assign U.S. counties and land parcels at random to enroll in the program. However, under the CRP enrollment mechanism, acres enrolled in CRP are not randomly assigned among counties. Thus, it is challenging to determine the causal impacts of the CRP on local employment using a simple ordinary least-squares (OLS) model. We apply a panel fixed effects model to examine the impact of CRP enrollment on local employment at the county-level. In addition, we utilize the Lewbel (2012) IV estimator as an alternative estimation procedure for a robustness check.

2.1 A Panel Fixed Effects Model

We seek to estimate the marginal effect of a change in CRP enrollment on employment for the agricultural sector, non-agricultural sector, and the whole economy. A reduced-form econometric model is specified as follows:

$$Y_{ct} = \beta CRP_{ct} + \alpha_c + \mu_t + \lambda X_{ct} + \epsilon_{ct} \tag{1}$$

where the outcome variable, Y_{ct}, is the employment in county c in year t. The outcome variables include the county-level the total number of jobs for the entire economy, and the number of farm and non-farm jobs for the agricultural and non-agricultural sectors respectively. CRP_{ct} is the change in stock of CRP enrollment in county c in year t from year $t-1$. This net change in the stock of CRP acres can be positive or negative. For instance, CRP enrollment from new sign-ups can lead to a positive change in enrollment, while expired CRP contract would result in a negative change in enrollment. The coefficient, β, is the main parameter of interest and represents the impact of a change in CRP

enrollment on local employment in county c conditional on the control variables, X_{ct} and other fixed effects.

The equation includes county fixed effects, α_c, which captures all unobserved county-specific time-invariant determinants of local employment such as unobserved soil and land features, time-invariant average labor required for each land parcel, and time-invariant average management abilities of landlords, which can also influence CRP enrollment decisions. The model also includes year fixed effects, μ_t, absorbing year to year, time-varying differences in the dependent variables that are common across counties.

The vector X_{ct} controls for three observed time-varying county characteristics that affect local employment. First, this model controls for the lagged weighted crop price[3] as crop prices can be correlated with the demand for farm labor and CRP enrollment (Secchi and Babcock, 2007; Hellerstein et al., 2011). Farmers are more likely to apply for the CRP and may ask for a lower rental payment when crop prices are low.

Second, oil and natural gas production are included in the regression model as controls. The fracking revolution unleashed a boom in oil and natural gas production in the U.S.. Previous research finds that an increase in exploration and production of oil and natural gas had a significant impact on employment (Agerton et al., 2017; Feyrer et al., 2017). Thus, without controlling for oil and gas production, the estimated effect of the CRP on employment may be biased as the fracking revolution affects local employment.

Third, the model controls for the lagged total cropland acres in each county. Previous literature shows that a slippage effect of CRP enrollment reduces the environmental benefits generated by the CRP since 20 out of every 100 acres enrolled in the CRP consist of non-cropland converted into cropland (Wu, 2000). This slippage may lead to biased effects of CRP enrollment in this model and can be addressed by controlling for total cropland acres in a county. This control is expected to be positively correlated with agricultural employment and negatively correlated with non-agricultural employment, since an increase in cropland acreage can provide more farm job opportunities. Inasmuch as additional croplands may increase or decrease the total number of jobs, the relationship

[3]The county-level weighted crop price is defined as the weighted average of the national crop prices. The planted acreage of each crop within a county is used as the weight in the calculation.

between total cropland acres and local employment for the entire economy is uncertain. We also include a linear time trends for metropolitan counties to separately capture other unobserved factors that change over time affecting county-level employment differently in metropolitan and non-metropolitan counties.

The last term, ϵ_{ct}, is the regression error, which contains variation due to unobserved factors or omitted variables. Standard errors are clustered at the county level to account for year-to-year correlations within a county. Equation 1 is applied to study the impact of the CRP on local employment for the entire economy and for the agricultural/non-agricultural sectors. Moreover, in the subsequent analysis, this equation is estimated separately for four different regions (Midwest, West, South, and North) and all parameters are allowed to vary across these regions.

The panel fixed effects model we use addresses endogeneity due to time-invariant unobservables. However, as a voluntary program, landowners within a county may be self-selected to apply for enrollment, which results in selection bias within a county because we cannot observe the land characteristics of enrolled parcels. For example, within a county, low-quality croplands are more likely to enroll in the program because of a lower opportunity cost of enrollment (Kirwan et al., 2005). Thus, instead of estimating the impact of the CRP enrolling any arbitrary additional one acre of croplands in a county, the panel fixed effects model estimates the impact of enrolling the kind of acres that tend to be selected through the current CRP enrollment process.

2.2 Robustness Check: Alternative Estimation Procedures

One approach to further address the potential endogeneity due to time and county varying unobservables that affect CRP enrollment and employment is to use a panel fixed effects model with IVs. However, this approach requires external IVs that are correlated with the potentially endogenous independent variable (a change in CRP enrollment) but only affect the employment through CRP enrollment (i.e., satisfying the IV exclusion restrictions). Unfortunately, in our case, we believe it is hard to find a valid external IV that can strongly satisfy the exclusion restriction. Therefore, we construct the Lew-

bel IV estimator (Lewbel, 2012) as a robustness check to assess whether estimates from the panel fixed effects model consist with the estimates from this alternative estimation method. The Lewbel IV can be applied to partly account for potential endogeneity in the model due to correlations between CRP enrollment and time-county-varying unobserved factors remaining in error term. This external IV-free estimator has been widely used in the literature when there is a lack of a credible, traditional instrumental variable (e.g., Chen et al. (2022); Banerjee et al. (2021); Millimet and Roy (2016)).

The Lewbel IV estimator uses heteroscedasticity in the error terms of the first-stage regression to identify the coefficient of endogenous variables in the second-stage when valid external instruments are not available. Specifically, it utilizes the variations in the variances of the residuals from the first-stage regression, such as the regression of the CRP enrollment (CRP_{ct}) on the observable covariates X_{ct}, to estimate the impact of CRP enrollment in local employment in the second-stage equation (Lewbel, 2012). The first stage regression in the Lewbel (2012) approach can be written as follows:

$$CRP_{ct} = \phi_x X_{ct} + \theta_{ct} \tag{2}$$

$(X_{ct} - \bar{X})\hat{\theta_{ct}}$, which is the exogenous covariates in demeaned form times the residuals from the first-stage equation, can be used as valid IVs in a standard 2SLS approach if the following two conditions are satisfied (1) there is heteroscedasticity in Equation 2 and (2) X_{ct} is not correlated with the covariance between the first-stage error term and the error term in the main second-stage equation (Baum and Lewbel, 2019).

3 Data and Summary Statistics

We use county-level CRP enrollment data from 1998 to 2019. Table 1 provides the summary statistics of variables used in the regression analysis. In the Appendix, Table A.1 lists all the dependent and independent variables used in the regressions, together with their data sources. Table A.2 shows the summary statistics by region.

CRP Enrollment Information

We obtain the CRP enrollment data from the USDA Farm Service Agency website.[4] It is a county-level dataset that reports the stock of CRP enrollment acres under contract at the end of each year from year 1998 to 2019. We calculate the county-level changes in CRP enrollment in year t by subtracting enrollment in year $t-1$ from year t and examine the effects of a change in CRP enrollment on local labor market.

Figure 1 (a) and (b) present the stock of CRP enrollment and CRP enrollment per acre of cropland in four regions during the study period. We observe heterogeneity in CRP enrollment across different regions. As a highly agriculturally-dependent region, the Midwest has the highest number of CRP enrollment acres among the four regions, while the Northeast has the lowest number of CRP enrollment acres. However, the West has the highest percentage of cropland enrolled in the CRP program compared to the Midwest. Figure 1 (c) shows the average changes in enrollment over time in each region. Compared to other regions, the West experienced significant changes in enrollment. CRP enrollment mainly increased from 1998 to 2008 and decreased in the next ten years in the West.

Employment Data

Data on local employment for the agricultural sector, the non-agricultural sector, and the entire economy come from the Bureau of Economic Analysis (BEA). We use farm employment data as the outcome variable when studying the labor market's impacts of the CRP on the agricultural sector. BEA defines farm employment as the number of workers engaged in the direct production of agricultural commodities, either livestock or crops, whether as a sole proprietor, partner, or hired laborer. In addition, we use data on the number of nonfarm jobs to examine the impact of the CRP on the labor market for non-agricultural sectors. Nonfarm employment is defined as the combination of nonfarm wage and salary employment and nonfarm proprietors' employment. Figure 3 presents the total number of nonfarm jobs and the number of nonfarm jobs per acre of land by region. While the Northeast has the lowest number of nonfarm jobs in absolute value, it has the highest number of nonfarm jobs per acre of land.

[4]https://www.fsa.usda.gov/programs-and-services/conservation-programs/reports-and-statistics/conservation-reserve-program-statistics/index

Finally, we use total employment, measured as the total number of jobs in each county, to examine the overall impacts of the CRP on the labor market. BEA defines the total number of jobs as the sum of the number of farm jobs and nonfarm jobs. Even though the Midwest and the South have a large number of farm jobs, the number of farm jobs is still a small portion of all the job opportunities available in each region (Figure A.2 in Appendix).

Control Variables

Several time-varying factors are controlled for in the regressions. First, we control for county-level cropland acres, which measure agricultural dependence in a county. Given that CRP enrollment would affect a county's cropland acres, we lag this variable by one year to avoid simultaneity. The cropland acreage data is obtained from the National Agricultural Statistics Service (NASS) of the USDA[5]. The aggregated cropland acreage is constructed by summing planted acreage of all field crops planted in each county each year, such as barley, cotton, corn, oats, peanuts, rye, rice, soybeans, sorghum, and wheat. Cropland acres are not reported in some counties due to data confidentiality. These counties have few harvested cropland acres, thus very low CRP enrollment. In order to control for cropland acres in the analysis, we drop counties with missing cropland data from the main sample (around 15% of observations are dropped). To explore the robustness of our results, we present the results without controlling for the cropland acres using both the full sample and the main sample in Table A.3 in the Appendix.

Second, we control for the lagged weighted crop prices in the analysis as the previous year's crop price may affect CRP enrollment decisions as well as labor market outcomes. The county-level weighted crop price is calculated as the weighted average of the national crop prices, while the planted acreage of each crop within a county is used as the weight in the calculation. Both the national crop price data and crop acreage data are obtained from the National Agricultural Statistics Service (NASS) of the USDA.

Third, we control for oil and gas production since large changes in that sector during

[5]The crop-specific land cover data from the Cropland Data Layer (CDL) is only available for the entire study period and areas. The CDL Program began with one state in 1997 and expanded to cover the entire Continental United States in 2008.

this time may have affected local employment. We obtain data on oil and natural gas production from Energy Information Administration (EIA). This data includes information on state-level monthly gross withdrawals of crude oil (barrels) and gross withdrawals of natural gas (thousand cubic feet).

Fourth, we include linear time trends for metropolitan and non-metropolitan counties to capture other factors that change over time differently in these two types of counties and may affect local labor markets.[6] Using the information from year 2019, 30% of counties in the sample are metropolitan counties.

4 Results

4.1 Estimated Impacts of the CRP on Local Employment for the Whole Nation

Table 2 shows the estimated impacts of a change in CRP enrollment on the number of farm jobs, non-farm jobs, and the total number of jobs for the whole nation under different specifications. County and year-fixed effects are controlled in all specifications. The observed time-varying control variables, oil and gas production, lagged cropland acres and lagged weighted crop prices, are included in all specifications. A linear time trend for metropolitan counties is included in Columns (2), (4), and (6).

Columns (1) and (2) of Table 2 show the impact of the CRP on the labor market for the agricultural sector using a panel fixed-effects model given by Equation 1. The results in Column (1) indicate that CRP enrollment has a negative effect on farm employment. After adding the linear time trends for metropolitan counties (Column (2)), the magnitude of the negative effects slightly decreases. If we add additional 1000 acres in the CRP per year in a county (or by about 8.5% if evaluated at the sample mean of the acres enrolled of 11,656 acres) would decrease the number of farm jobs by 1.307 (or by about

[6]According to the U.S. Office of Management and Budget, Metropolitan counties are defined as counties containing an urbanized area of 50,000 or more population or are adjacent to such a county and linked to it based on a high degree of social and economic integration with the core as measured by commuting ties

0.014% if evaluated at the sample mean of the number of farm jobs of 926.1).

Columns (3) and (4) of Table 2 show the impacts of the CRP on non-farm employment. After controlling for fixed effects and other observed time-varying factors that may affect CRP enrollment and employment, we observe a positive but insignificant effect of the CRP on the number of non-farm jobs. The effect becomes negative but remains insignificant after including the linear time trend. A positive and significant coefficient associated with the linear time trend suggests that the growth path in the labor market for non-agricultural sectors would differ in metro and non-metropolitan counties.

The results above suggest that CRP enrollment has a negative impact on the number of jobs in the agricultural sector. However, it does not significantly affect the labor market in the non-agricultural sectors. Given that the agricultural sector only provides on average 2% of jobs of the entire economy, it is no surprise to see that CRP enrollment does not have any significant impact on the overall labor market (Table 2 Column (5) and (6)).

4.2 Heterogeneity in the Impacts of CRP Enrollment on Farm Employment by Region

There are significant differences in the types of crops grown, land and climate characteristics, and labor demand for agricultural production across the regions of the U.S. Furthermore, major industries vary significantly across regions. As a result, we may expect CRP enrollment to have differential effects on farm and non-farm employment. To explore such heterogeneity, we estimate the effects of the CRP in four regions (the Midwest, the South, the West, and the Northeast) in the U.S. using a panel fixed-effects model. Table 3 provides the estimated impacts of the CRP on the number of farm jobs, non-farm jobs, and the total number of jobs by region. County and year fixed-effects, as well as additional time-varying controls, are included in all specifications.

Results in Column (1) Table 3 indicate that CRP enrollment has a negative and significant impact on the number of farm jobs in the Northeast and the West. The results still hold after controlling for the linear time trend in metropolitan counties (Column (2)).

Focusing on the results in Table 3 Column (2), all else equal, if CRP enrollment increases by 1000 acres in a year in a county, then the number of farm jobs in that county decreases by 19.2 in the Northeast and 2.1 in the West. Based on the summary statistics in Table A.2, on average, a 10% increase in the stock of CRP enrollment would lead to a 0.28% decrease in the number of farm jobs in the Northeast and 0.32% reduction in the West. However, the CRP does not significantly affect farm employment in the Midwest and South. The estimated effects in these two regions are negative but insignificant.

These results might be counterintuitive at first glance, given that the Midwest is highly agriculturally dependent and accounts for more than 47% of CRP enrollment. However, Figure 2 shows that the Midwest has the lowest number of farm jobs per cropland acre (0.005 farm jobs per cropland acre); the number of farm jobs per acre required in the Northeast and the West is more than six times and five times higher, respectively, than in the Midwest. The significant differences in labor requirements are mainly due to farm types and the crop types planted in these regions. For instance, while the Midwest has large farms of annual raw crops that exploit economies of scale and use little labor, the Northeast has many small farms and the West grows many labor-intensive specialty crops such as fruits, vegetables, and tree nuts. While only 4.9 percent of farm production expenditures in Midwest go to labor, that percent is more than 23% in the West and as high as 30% in California (Farm Production Expenditures Report, 2019). Thus, it is reasonable that retiring croplands has a relatively large impact on local agricultural labor markets there.

4.3 Impacts of the CRP on Non-agricultural Employment

We break down the non-farm employment by industries based on the NAICS standard and explore how a change in CRP enrollment affects the number of jobs in recreation-related sectors. Results are shown in Table 4. All regressions include county and year-fixed effects and time-varying control variables.

Due to data limitations, regression analyses in Table 4 only use data ranging from

2000 to 2019.[7]Moreover, some counties' data on the number of jobs in some industry divisions are not available due to restrictions on the disclosure of confidential information. Thus, results in Table 4 present the estimated impact of CRP enrollment in each industry division using different subsamples to maximize the sample size in each regression analysis. As we can see from Table 4, CRP enrollment has a positive and significant impact on the number of jobs in recreation and service (Panel A column (1) and (2)), which includes establishments that meet cultural, entertainment, and recreational interests, as well as lodging and food services. This supports the hypothesis that as the CRP retires active croplands, the improved landscape provides more or better recreation opportunities and simulates the establishments of small local businesses (Goetz and Rupasingha, 2002; Wirtz et al., 2002). We also observe a positive impact of the CRP on the number of jobs in the real estate and rental industry, which may suggest that improved environmental amenities can attract more people and lead to higher housing demand in the region.

To ensure the findings in Table 4 are comparable across different industry divisions, as a robustness check, we obtain a subsample of 31,510 observations by dropping counties out of the sample if they have missing data in any industry division. Table A.4 in the Appendix shows the estimated impact of CRP enrollment in each industry division based on the subsample we constructed. Compared to findings in Table 4, we observe consistent findings with considerably larger effects magnitudes.

Turning attention to the estimated impacts of the CRP on non-agricultural sectors and the overall economy, we find that CRP enrollment has no effect on the number of all non-farm jobs and the total number of jobs in any sector in all four regions in the U.S. (Table 3 Column (3)-(6)), a finding that is consistent with what we observe for the aggregated effects in the whole U.S. The results show that the CRP program has a direct impact on agricultural employment by retiring cropland, but the indirect effects of the CRP may have on the labor market for the non-agricultural industries are insignificant, and there is no evidence that the CRP harms total local employment.

[7]BEA provides data on the number of jobs in each industry division from the year 1969 to the year 2000 based on the SIC standard and from the year 2000 to current based on the NAICS standard. However, the data are not comparable using the two types of standards for each industry division.

4.4 Robustness checks: Alternative estimation

As a robustness check, we use the Lewbel IV estimator as an alternative estimation method to examine the impacts of CRP enrollment on local employment for the whole U.S. We construct the external-free instruments using the demeaned exogenous covariates times the residuals from the first-stage equation. To ensure the validity of the constructed instruments, first, as outlined in Breusch and Pagan (1979), we use the Breusch-Pagan (BP) test to verify heteroscedasticity in the first stage regression. The BP test results show that the null hypothesis of homoscedasticity is rejected (p-value <0.01, BP test statistic: 22.87), indicating that the first condition is met. Moreover, as suggested by Baum and Lewbel (2019), we use the Hansen J test as an overidentifying-type test to test the satisfaction of condition (2) discussed in Section 2.2. The results of the Hansen J test show that the constructed IVs are valid (i.e., Hansen J statistics is 35.51 with a p-value of 0.14 for outcome variable farm jobs, 25.49 with a p-value of 0.44 for nonfarm jobs, and 25.94 with a p-value of 0.41 for the total number of jobs).

The robustness check results presented in Table 5 show that the CRP has a negative and significant effect on farm employment, which aligns with the findings of the panel fixed effects model. An increase of 1000 acres in CRP enrollment in a year in a county would decrease 1.331 farm jobs. The magnitude of the CRP effects is slightly higher than our results from the panel fixed effects model. Additionally, the results suggest that CRP enrollment does not significantly affect the number of nonfarm jobs and the total number of jobs in a county, which is also consistent with findings from the panel fixed effects model.

5 Discussion and Conclusion

This paper utilizes the most recent data on CRP enrollment to study the reduced-form effects of the CRP on local employment for the entire U.S. to generate a nationwide analysis of the impacts of agricultural land retirement on the local rural economy. Using a panel fixed-effects model, we estimate the marginal effects of CRP enrollment for the

entire U.S. and by region. Results show that additional 1000 acres enrolled in the CRP in a year in a county would decrease the number of farm jobs by 1.3. This effect is mainly driven by farm employment changes in specific regions in the U.S. The effects of the CRP on farm employment are insignificant in the Midwest and South, where per acre farm labor requirement is low. At the same time, CRP enrollment reduces the number of farm jobs in the West and Northeast. This may appear to be troubling for farm workers in those regions. However, labor-intensive agriculture has been struggling with growing scarcity of farm labor; farmland retirement might join other strategies like mechanization in mitigating this challenge (Taylor et al., 2012; Shockley et al., 2022).

While the CRP decreases farm employment in certain regions in the U.S., improved natural amenities from CRP enrollment may promote rural development by making the landscape more attractive to tourists, residents, and local businesses. We find support for that hypothesis as increased CRP enrollment increases the number of non-farm jobs in industry divisions related to recreation, food, and lodging services. This finding confirms that CRP enrollment may provide more non-farm job opportunities through increased recreation activities. However, the recreation-related non-farm jobs only account for a small portion of the total economy; the impact of the CRP on aggregated non-farm job opportunities is insignificant. Even though CRP enrollment has a direct and negative impact on farm jobs in some regions, overall, we do not find evidence that the CRP harms total local employment. These results are robust to using an estimation strategy with IVs

As the largest federally funded farmland retirement program in the U.S., the CRP distributes around $2 billion per year to improve environmental quality. Debates over the CRP have continued for years, with many policymakers and rural stakeholders concerned about the potential impact of the CRP on the health of rural economies. Future debates over the scale and geographic focus of the CRP and other agricultural conservation programs may draw on the results of this research to provide region-specific up-to-date estimates of the economic effects of farmland retirement in the U.S. to inform decision about this large and important policy, and others like it.

6 Tables and Figures

Table 1: Summary statistics

Statistic	N	Mean	St. Dev.	Min	Max
Total number of jobs	54,234	45,142.5	154,289.8	179	5,693,811
Farm jobs	54,234	926.1	1,154.8	0	34,757
Non-farm jobs	54,234	44,216.4	153,996.2	106	5,687,109
Recreation Related Non-farm jobs:					
Accommodation & food.services	36,022	3,905.1	11,914.5	0	357,490
Arts, entertainment $ recreation	36,115	1,103.6	4,070.2	0	194,241
Real estate and rental	39,960	2,051.2	7,645.8	0	300,940
Explanatory variables					
Enrollment change(1000 acres)	54,234	-0.2	2.6	-97.3	114.1
Cropland acres	54,234	100,324.4	110,938.6	14	954,300
Weighted crop price	54,234	43.6	47.1	0.2	184.0
Gas production	54,234	93,991.6	627,741.9	0	5,798,893
Oil production	54,234	61,954.2	198,150.2	0	1,864,287

Note: Enrollment change is the change in stock of CRP enrollment in county c in year t from year $t-1$. This net change in the stock of CRP acres can be positive or negative. County and year-fixed effects are controlled in all specifications.

Table 2: Estimated impacts of CRP enrollment on the number of jobs

	Dependent variable: Number of jobs					
	Farm		Nonfarm		Total	
	(1)	(2)	(3)	(4)	(5)	(6)
Enrollment Change	−1.460***	−1.307***	10.897	−10.684	9.437	−11.990
	(0.355)	(0.332)	(15.458)	(13.434)	(15.408)	(13.431)
Cropland (lag)	0.0001	0.0001	−0.006	−0.008*	−0.006	−0.008*
	(0.0002)	(0.0002)	(0.005)	(0.004)	(0.005)	(0.004)
Oil Production	0.0001***	0.0001***	0.008**	0.009**	0.008**	0.009**
	(0.00002)	(0.00002)	(0.004)	(0.004)	(0.004)	(0.004)
Gas Production	−0.00001***	−0.00001***	−0.001***	−0.001***	−0.001***	−0.001***
	(0.00000)	(0.00000)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Weighted crop price (lag)	0.409***	0.400***	18.505*	19.780*	18.914*	20.180*
	(0.086)	(0.085)	(10.526)	(10.317)	(10.514)	(10.307)
Trend for metropolitan		−6.373***		895.391***		889.019***
		(1.490)		(101.985)		(101.671)
County&Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,234	54,234	54,234	54,234	54,234	54,234
Adjusted R^2	0.968	0.969	0.993	0.994	0.993	0.994

*p<0.1; **p<0.05; ***p<0.01

Note: This table shows the estimated impacts of the CRP on the number of farm jobs, non-farm jobs, and the total number of jobs for the whole nation using a panel fixed-effects model. Enrollment change is the change in stock of CRP enrollment in county c in year t from year $t-1$. This net change in the stock of CRP acres can be positive or negative. County and year-fixed effects are controlled in all specifications. A linear time trend for metropolitan counties is included in Columns (2), (4), and (6).

Table 3: Estimated impacts of CRP enrollment by region

	Dependent variable: Number of jobs					
	Farm		Nonfarm		Total	
	(1)	(2)	(3)	(4)	(5)	(6)
Enrollment Change - Midwest	−0.647*	−0.467	13.526	−11.643	12.880	−12.110
	(0.352)	(0.322)	(16.881)	(15.365)	(16.809)	(15.381)
Enrollment Change - Northeast	−19.012**	−19.227**	27.385	57.697	8.373	38.469
	(8.824)	(9.051)	(294.673)	(247.865)	(297.406)	(250.385)
Enrollment Change - South	−0.790	−0.745	1.079	−5.174	0.289	−5.920
	(0.525)	(0.543)	(38.283)	(33.598)	(38.412)	(33.740)
Enrollment Change - West	−2.312***	−2.144***	11.869	−11.767	9.557	−13.911
	(0.683)	(0.657)	(24.235)	(19.247)	(24.142)	(19.241)
Cropland (lag)	0.0001	0.0001	−0.006	−0.008*	−0.006	−0.008*
	(0.0002)	(0.0002)	(0.005)	(0.005)	(0.005)	(0.004)
Oil Production	0.0001***	0.0001***	0.008**	0.009**	0.008**	0.009**
	(0.00002)	(0.00002)	(0.004)	(0.004)	(0.004)	(0.004)
Gas Production	−0.00001***	−0.00001***	−0.001***	−0.001***	−0.001***	−0.001***
	(0.00000)	(0.00000)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Weighted crop price (lag)	0.409***	0.400***	18.503*	19.771*	18.912*	20.171*
	(0.086)	(0.085)	(10.531)	(10.321)	(10.518)	(10.310)
Trend for metropolitan		−6.373***		895.409***		889.036***
		(1.490)		(101.993)		(101.679)
County&Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,234	54,234	54,234	54,234	54,234	54,234
R^2	0.970	0.970	0.994	0.994	0.994	0.994

*p<0.1; **p<0.05; ***p<0.01

Note: This table shows the effects of the CRP on the number of farm jobs, non-farm jobs, and the total number of jobs in four regions (the Midwest, the South, the West, and the Northeast) using a panel fixed-effects model. Enrollment change is the change in stock of CRP enrollment in county c in year t from year $t-1$. This net change in the stock of CRP acres can be positive or negative. County and year fixed-effects, as well as additional time-varying controls, are included in all specifications. A linear time trend for metropolitan counties is included in Columns (2), (4), and (6).

Table 4: The impacts of CRP enrollment on the number of non-farm jobs in recreation-related sectors

	Entertainment& Recreation	Accommodation & Food Services	Real estate & Rental
	(1)	(2)	(3)
Enrollment Change	2.641***	5.870***	7.906***
	(0.708)	(1.991)	(1.677)
County & Year FEs	Yes	Yes	Yes
Other time-varying controls	Yes	Yes	Yes
Observations	34,774	34,691	38,440
R^2	0.987	0.990	0.982

Note: *p<0.1; **p<0.05; ***p<0.01

This table shows how CRP enrollment affects the number of jobs in recreation-related sectors. County and year-fixed effects as well as time-varying controls are included in all specifications. Due to data limitations, regression analyses only use data ranging from 2000 to 2019. Enrollment change is the change in stock of CRP enrollment in county c in year t from year $t-1$. This net change in the stock of CRP acres can be positive or negative.

Table 5: Robustness check: Lewbel IV estimation strategy

	(1) Farm	(2) Nonfarm	(3) Total
Enrollment Change	-1.331***	-24.83	-26.17
	(0.328)	(25.14)	(25.09)
Cropland (lag)	0.000108	-0.00764***	-0.00753***
	(6.95e-05)	(0.00246)	(0.00246)
Weighted crop price (lag)	0.400***	19.85***	20.25***
	(0.0337)	(2.628)	(2.623)
Oil Production	0.000109***	0.00873***	0.00884***
	(7.07e-06)	(0.000527)	(0.000526)
Gas Production	-1.22e-05***	-0.000916***	-0.000928***
	(1.15e-06)	(0.000102)	(0.000102)
Trend for metropolitan	-6.372***	895.7***	889.3***
	(0.523)	(18.38)	(18.34)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Hansen J statistic [P value]	31.51[p=0.14]	25.49 [p=0.44]	25.94[p=0.41]
Observations	54,234	54,234	54,234
R-squared	0.112	0.093	0.092
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Note: This table shows the Lewbel IV estimator on impacts of CRP enrollment change on the number of farm jobs, non-farm jobs, and the total number of jobs for the whole nation. County and year-fixed effects are controlled in all specifications. Enrollment change is the change in stock of CRP enrollment in county c in year t from year $t-1$. This net change in the stock of CRP acres can be positive or negative.

7 Figures and Tables

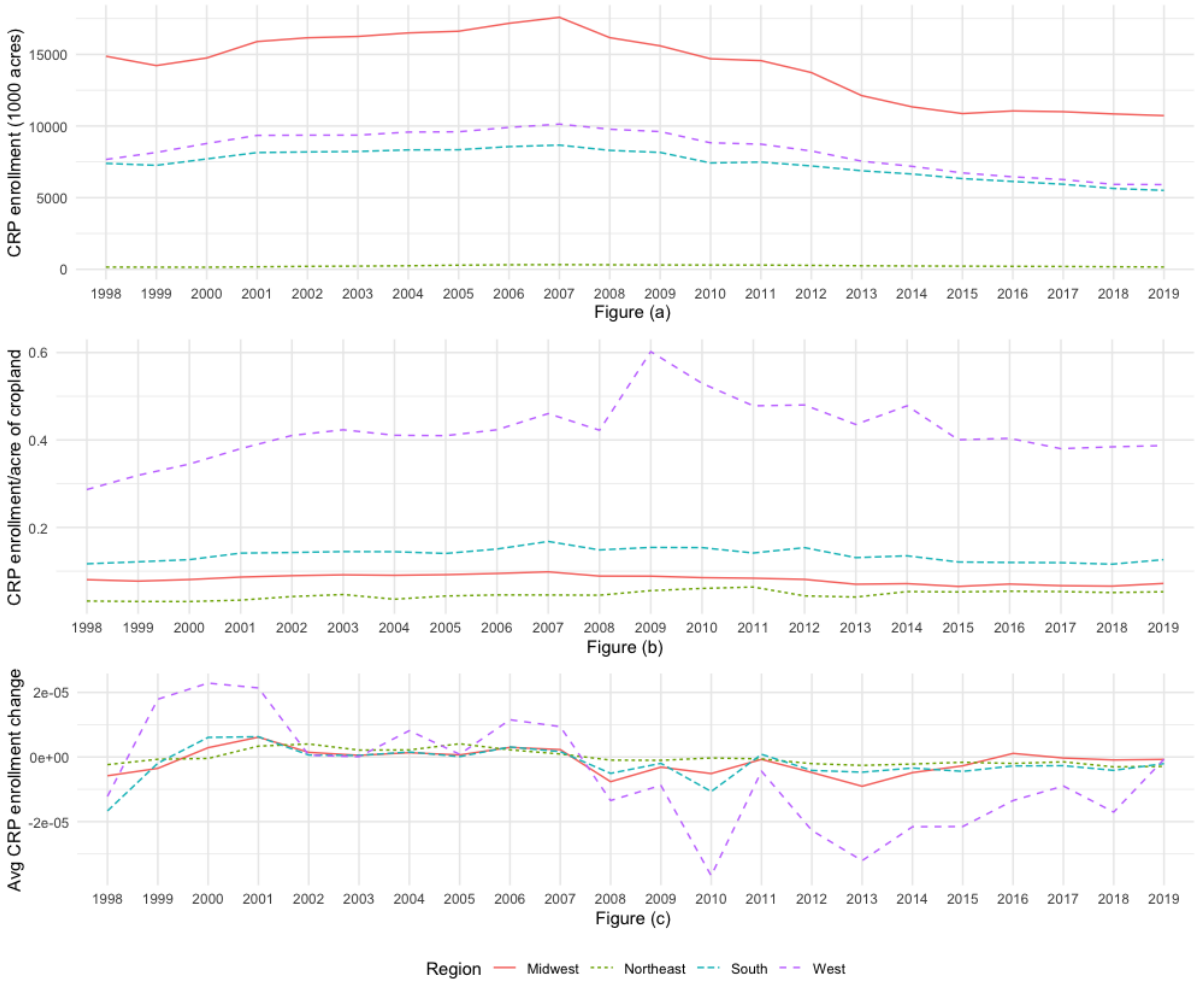

Figure 1: CRP enrollment (stock) by region in Year 1998-2019

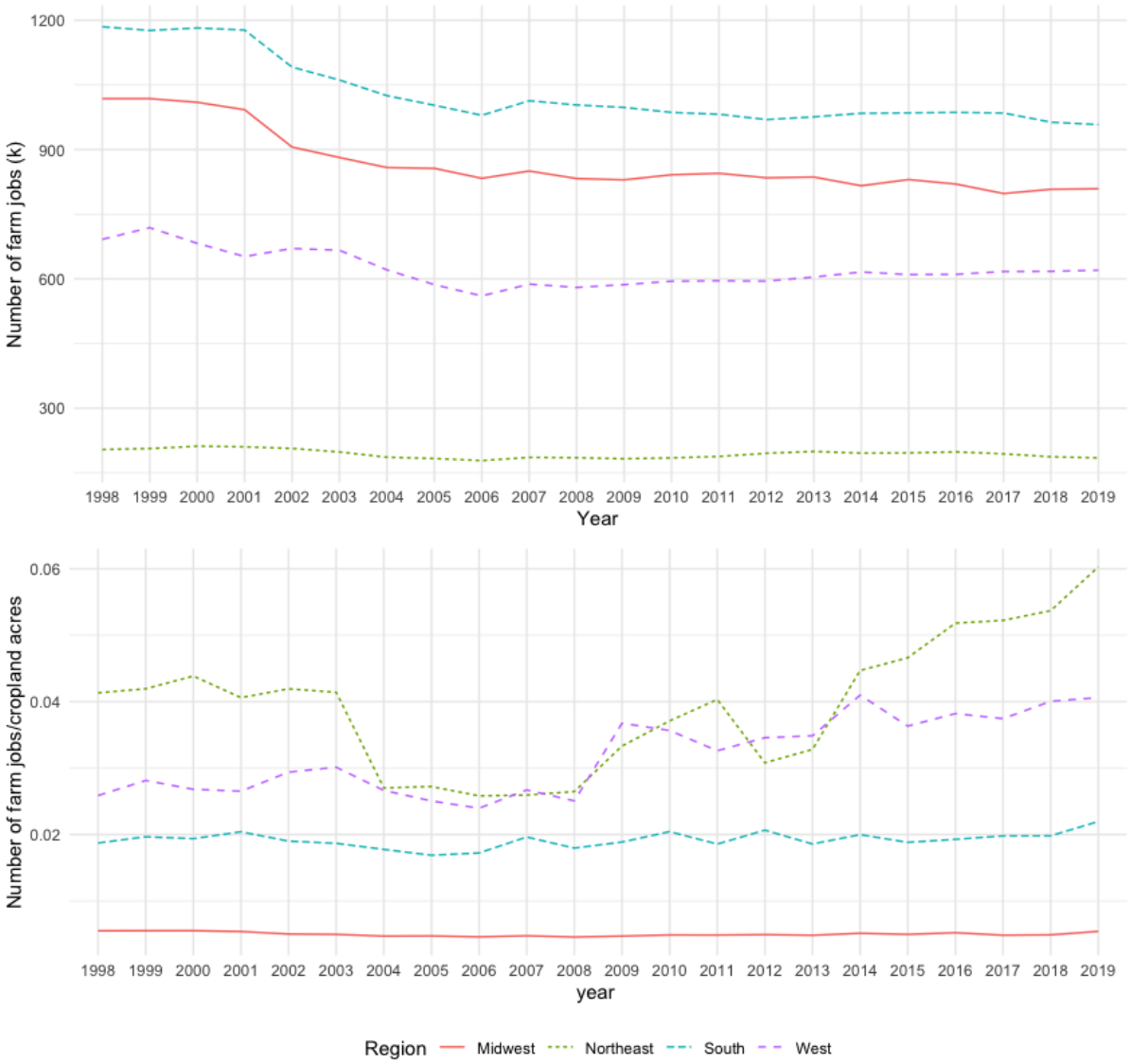

Figure 2: Number of farm jobs by region

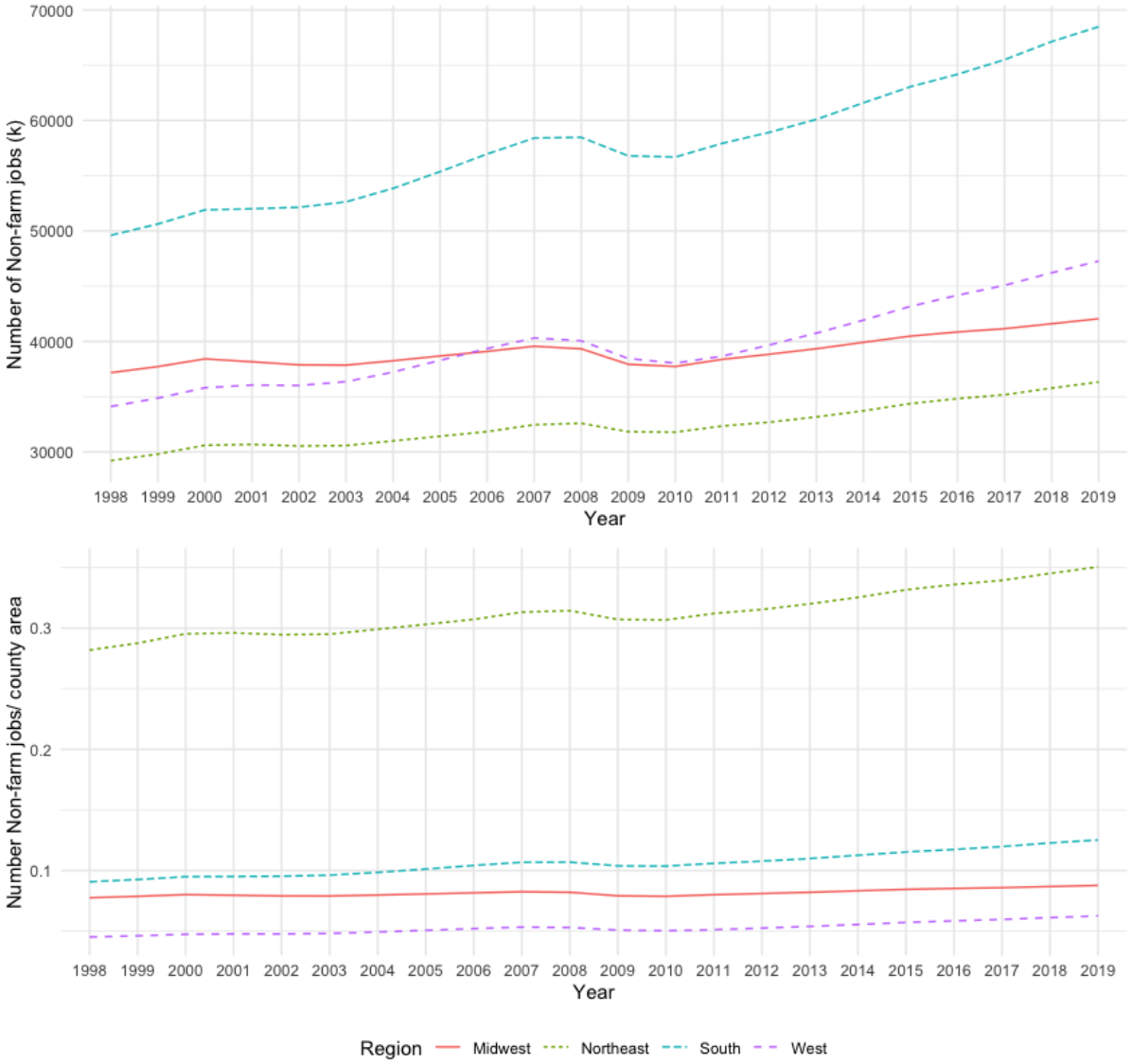

Figure 3: Number of non-farm jobs by region

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A Appendix A

Table A.1: Description of Variables

Variable	Level	Unit	Source
CRP enrollment (stock)	County	acre	FSA
Cropland acres	County	$	NASS [2]
Weighted crop price	County	$	NASS [2]
Farm Employment	County	number of farm jobs	BEA[3]
Non-farm Employment	County	number of farm jobs	BEA[3]
Total number of Jobs	County	number of jobs	BEA[3]
Oil production	State	Thousand Barrels	EIA[4]
Gas production	State	million cubic feet	EIA[4]

[1] This table lists variables applied in the empirical analysis. It contains the level, unit, and data source of the variables.
[2] National Agricultural Statistic Service
[3] Bureau of Economic Analysis
[4] U.S. Energy Information Administration

Table A.2: Summary Statistics by Region

Variable	**Region**	**N**	**Mean**	**St. Dev**	**Min**	**Max**
Farm jobs	Midwest	21,830	841.7	482.2	36	4,369
	Northeast	2,748	1,110.4	904.8	29	8,100
	South	22,045	796.5	570.5	0	4,244
	West	7,611	1,477.2	2,685.6	0	34,75
Non-farm jobs	Midwest	21,830	35,409.7	127,628.3	106	3,547,768
	Northeast	2,748	102,892.7	144,953.7	1,982	930,754
	South	22,045	36,041.8	110,731.3	109	2,691,387
	West	7,611	71,967.8	277,034.9	142	5,687,109
Total number of jobs	Midwest	21,830	36,251.4	127,657.6	226	3,547,994
	Northeast	2,748	104,003.1	145,143.6	2,035	931,253
	South	22,045	36,838.2	110,843.2	179	2,693,786
	West	7,611	73,445.0	277,904.9	255	5,693,811
Enrollment (stock)	Midwest	21,830	13,815.5	19,981.2	0	205,645
	Northeast	2,748	1,660.1	2,454.0	0	20,048
	South	22,045	6,797.6	18,563.0	0	218,481
	West	7,611	23,147.7	48,032.3	0	310,296
Enrollment change (1000 acres)	Midwest	21,830	−0.2	2.6	−47.0	64.9
	Northeast	2,748	0.01	0.4	−2.3	6.6
	South	22,045	−0.1	1.6	−56.0	35.0
	West	7,611	−0.2	4.8	−97.3	114.1

Note: Enrollment change is the change in stock of CRP enrollment in county c in year t from year $t-1$. This net change in the stock of CRP acres can be positive or negative. County and year-fixed effects are controlled in all specifications.

Table A.3: Estimated impacts of CRP enrollment on the number of jobs - full sample and main sample

	Dependent variable: number of jobs					
	Farm		Nonfarm		Total	
	(1)	(2)	(3)	(4)	(5)	(6)
Enrollment Change	−0.986***	−1.307***	3.011	−10.684	2.025	−11.990
	(0.293)	(0.332)	(12.327)	(13.434)	(12.349)	(13.431)
Cropland (lag)		0.0001		−0.008*		−0.008*
		(0.0002)		(0.004)		(0.004)
Oil Production	0.0001***	0.0001***	0.006*	0.009**	0.007*	0.009**
	(0.00001)	(0.00002)	(0.004)	(0.004)	(0.004)	(0.004)
Gas Production	−0.00001***	−0.00001***	−0.001**	−0.001***	−0.001**	−0.001***
	(0.00000)	(0.00000)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Weighted crop price (lag)		0.400***		19.780*		20.180*
		(0.085)		(10.317)		(10.307)
Trend for metropolitan	−5.364***	−6.373***	943.051***	895.391***	937.687***	889.019***
	(1.321)	(1.490)	(123.855)	(101.985)	(123.528)	(101.671)
Observations	67,012	54,234	67,012	54,234	67,012	54,234
R^2	0.969	0.970	0.991	0.994	0.991	0.994

Note: *p<0.1; **p<0.05; ***p<0.01

Note: Cropland acres are not reported in some counties due to data confidentiality. These counties have few harvested cropland acres, thus very low CRP enrollment. In order to control for cropland acres in the analysis, we drop counties with missing cropland data from the main sample (around 15% of observations are dropped).Column (1) (3) (5) show the results for the full sample without controlling for cropland acres (lag). Column (2) (4) (6) the estimated impacts using the main sample (same as results presented in Table 2 after dropping counties with missing cropland data. Enrollment change is the change in stock of CRP enrollment in county c in year t from year $t-1$.

Table A.4: The impacts of CRP enrollment on the number of non-farm jobs by sector (balanced sample)

	Entertainment & Recreation	Accommodation & Food Services	Real Estate & Rental
	(1)	(2)	(3)
enroll_change	3.588***	8.070***	9.604***
	(0.909)	(2.515)	(2.114)
Observations	31,510	31,510	31,510
R^2	0.987	0.990	0.982

Note: *p<0.1; **p<0.05; ***p<0.01

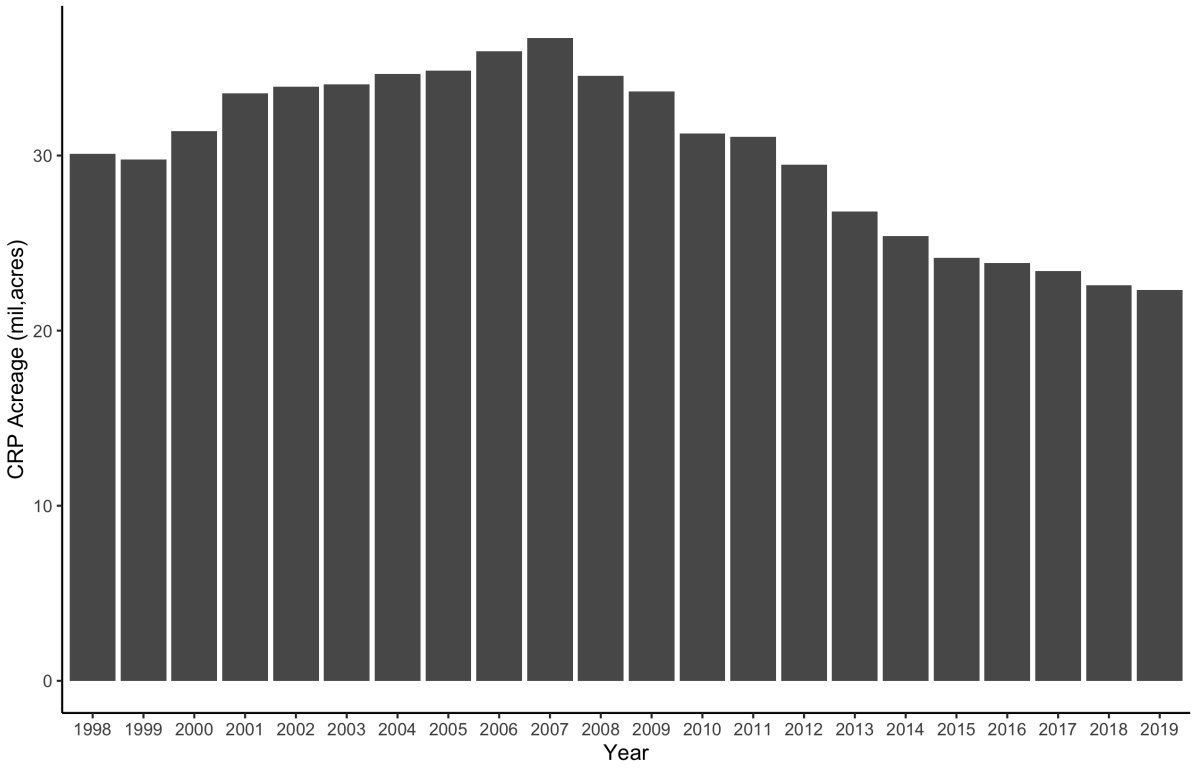

Figure A.1: CRP enrollment (stock) in Year 1998-2019

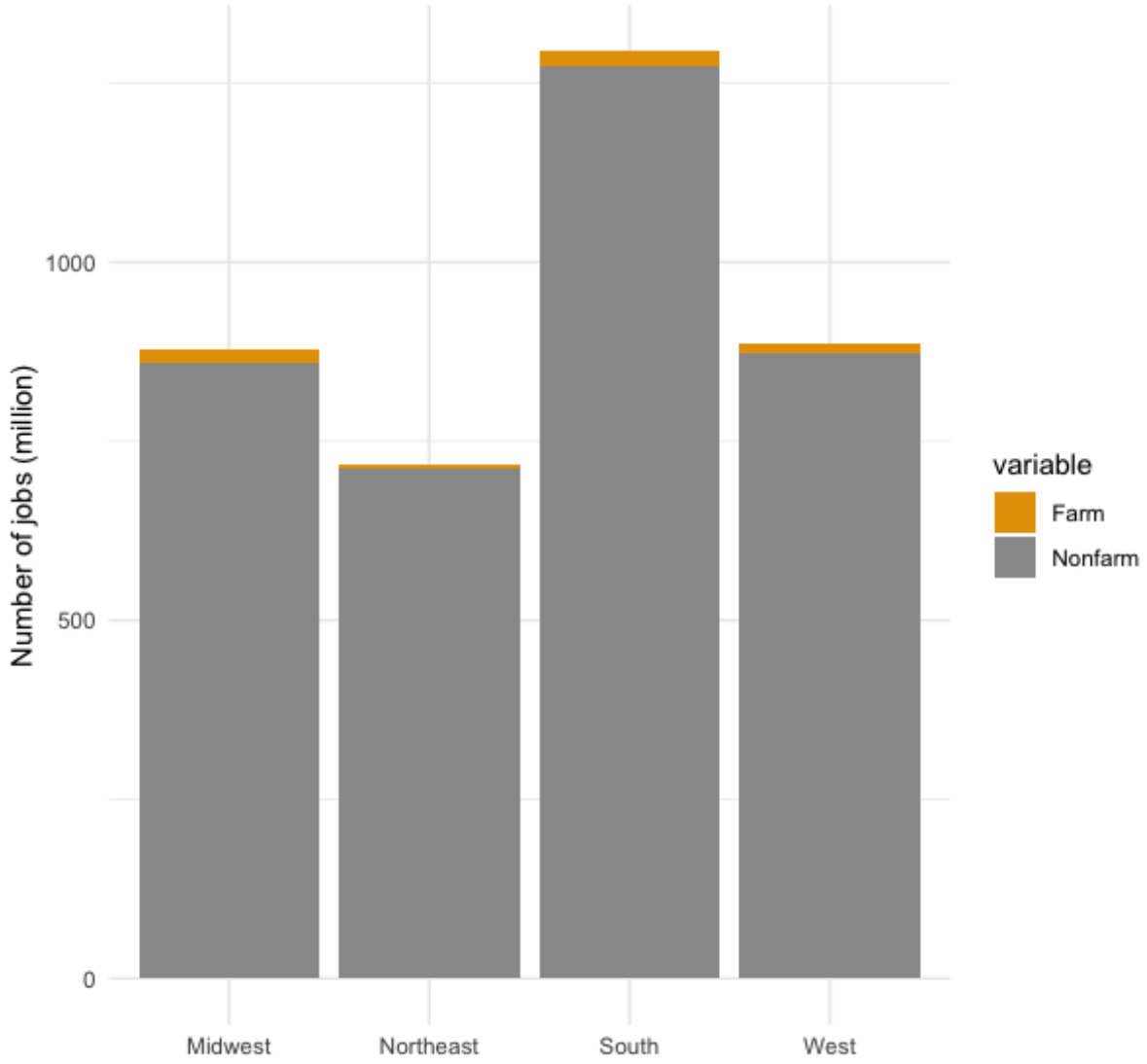

Figure A.2: Total number of jobs by region