## The Local Economic Impact of the Farm Boom: A Spatial Econometric Perspective

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**Abstract:** Resources based economies in the United States may be fundamentally subject to the fluctuations of the prices of the resources used. Commodity price booms have been shown to have significant spillover effects on employment and earnings in the other local industries. For example, the coal boom in the 1970s had been a shock to both mining and non-mining industries across the US. We examine similar issue in the case of corn prices in the Midwest. The paper builds off of the work of Black, McKinnish and Sanders (2005), who examined the economic impact of the coal boom and bust on the mining and non-mining sectors in terms of employment and earnings. In their study, they did not include spatial spillover effects which we considered to be important in terms of employment and earnings. Through the fixed effects spatial autoregressive model, spillover effects across industries and States are captured. The motivation behind the use of spatial econometrics is that, the impacts of corn price shocks in the farm sector expand into the local sectors both in the source counties and the neighboring counties. Specifically, employment and earnings have experienced the substitution effects between farm sector and the local sectors. With regard to the time trend of the corn prices, non-boom and boom period were defined, and the spatial spillover effects are more pronounced during the boom period.

***Keywords*:** corn prices boom, employment, earnings and spatial panel data analysis

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## 1. Introduction

Commodity booms and busts have been a key characteristic of the global economy, particularly in recent years. Such booms and busts have important macroeconomic consequences but localized economic impacts are also a consideration. Significant booms (or busts) in commodity industry employment, earnings, and profits often accompany commodity price booms (or busts). The question is the extent to which these fluctuations in commodity industries spill over into other local industries. Alternatively, growth in commodity industries may lead to a decline in other industries, presumably as the commodity industries attracts local labor resources.

This study examines the impact of the recent agricultural commodity boom, as proxied by corn prices, in local economies in four Midwestern states. Corn prices have risen due to a weak dollar, growing demand for agricultural products in developing countries, and growth in ethanol production.[1] . The paper builds off of the work of Black, McKinnish and Sanders (2005), who examined the economic impact of the coal boom and bust on the mining and non-mining sectors in terms of employment and earnings. In terms of methodology, our approach also follows a number of papers that have worked to identify the spillover impacts of major transportation investments, or export growth, in local economies. For example, Carrington (1996) worked on the effects of the construction of Trans-Alaska oil pipeline (TAPS) on the construction sector. Gkritza, Kumares, Labi, Mannering and Sinha (2008) assessed the influence of highway construction projects on economic development. Thompson (2007) looked at the impact of tourism on rural development.

[1] For example, Petersan (2003) argued that one Nebraska ethanol processing facility has a positive effect on area corn prices averaging 4.83 cents per bushel over a multi-county impact area.

In this paper we grasp the opportunity of the sharp increase in the corn prices from 2006 until present and examine its effects on the employment and earnings of farm and non- farm sectors using panel data analysis. As shown by Figure 1, national corn prices have reached its highest level begining in 2006 since the 1800s.

[Insert Figure 1]

In the following sections, we review the literature that dealt with the effects of projects on local economic growth, show the theory used, provide the description of data, present our empirical findings and finally provide a brief conclusion.

## 2. Literature Review

There are myriad of studies that have been conducted to examine the impact of some particular projects on the growth of the local economies. Chandra and Thompson (2000) conducted a study to assess how the introduction of interstate highways into non-metropolitan areas influenced subsequent growth in worker earnings in counties. Using the OLS regression framework, they found that the construction of a new highway raises economic growth as measured by total earnings, in counties that the highway directly passes through, but found no net impact on the entire regional economy. In his article "The Alaskan Labor Market during the Pipeline Era", Carrington (1996) showed that the construction of Trans-Alaska pipeline between 1974 and 1977 was the ideal opportunity to view labor market responses to a large, anticipated, and temporary shock to labor demand. He carried his research using a dynamic Model of Wage Leadership in which he found that employment and earnings have experience  a very large in the period of Trans- Alaska pipeline mainly in the construction sector. In addition, the spillover effects in terms of labor demand were remarkable from the construction sector to the transportation, services, financial and trade industries. Gkritza et al (2008) assessed the influence of highway construction projects on economic development. They used single and simultaneous-equation approaches to show that the size of added-lanes highway projects is a significant factor in determining economic impact.  In other words, the larger the project the greater its impact on economic activity measured in terms of employment, income, output and gross regional product. Other studies have examined the economic impact on the resources based economies when there is a boom or particular projects. For example; Black, McKinnish and Sanders examined the impacts of coal boom in the 1970s and the subsequent coal bust in the 1980s on counties in Appalachia with substantial coal mining activity. Using the panel data approach, they found that spillovers from the coal shocks would be greater in this region than in areas located in urban areas. In addition, according to their research, Black et al estimated that for each 10 jobs produced in the coal sector during the boom, fewer than two jobs produced in the local goods sectors of construction, retail and services.

## 3. Theoretical Models

### 3.1 Directs Effects

The direct effects of the corn price boom are estimated in two fold. First, the approach from Black et al. (2005) was mimicked. Second, the difference in difference estimation was implemented in order to address more precisely the impact of the boom. Both approaches are described in the next two sections.

#### 3.1.1 Black's approach

To account for the direct effects of the corn price boom, we estimate the equations 1 and 2 using Pooled OLS regression.

$$Y_{it} = \beta_0 + \beta_1(T_r P_1) + \beta_2(T_r P_2) + (State_s{*}Period_t)\,\phi + \varepsilon_{it} \qquad (1)$$

$Y_{it}$ stands for compounded annual growth rate of employment or earnings for county i in period t. $T_r$ is an indicator variable for whether the regions belong to the treatment group or not. Therefore, $T_r$ =1 for treatment and $T_r$=0 for comparison. $P_1$ and $P_2$ are the indicators of the non-boom and boom periods, respectively. The period between 2006 and 2011 period is considered as boom for the simple reason that the corn prices has increased sharply during that period. For example, the corn prices have increased by 52% and 46% in 2006 and 2010, respectively. From the equation1, $\beta_1$ and $\beta_2$ measure the difference in average growth between treated and controls counties during the boom and non-boom periods (Black et al. 2005).$State_{s*}Period_t$ variable controls for anything that varies over time at the State level, where $State_s$ stands for the four states Nebraska, Illinois, Iowa and South Dakota, and the period $_t$ for the non-boom and the boom periods.

### 3.1.2 Difference in Difference

$$Y_{it} = \beta_0 + \beta_1 T_r + \beta_2 P_2 + \beta_3 (T_r P_2) + (State_s * Period_t)\phi + \varepsilon_{it} \quad (2)$$

Unlike the equation 1, this equation emphasizes the impact of the boom period in the treated counties. $\beta_1$ represents the differences between treated and control counties during the non-boom period, β2 represents the time trend in the control group, and $\beta_3$ represents the difference in difference changes.

### 3.2 Spillovers Effects: Fixed Effects Spatial Autoregressive Model

Following Luc et al. (2008), the fixed effects spatial autoregressive model is described as follow: In the stacked form, the simple pooled regression is defined as

$$y = X\beta + \varepsilon, \quad (3)$$

with y as NTx1 vector, X as a NTxK matrix and ε as NTx1 vector. Assuming that the presence of spatial dependence across cross- sectional units is uniform overtime, the spatial autoregressive model is expressed as:

$$y = \rho(I_T \otimes W_N)y + X\beta + \varepsilon, (4)$$

The full NT xNT weights matrix is

$$W_{NT} = I_T \otimes W_N,$$

$I_T$ is an identity matrix of dimension T; $W_N$ are the weights for cross –sectional dimension. Also, ρ is the spatial autoregressive parameter. In order to capture the spillovers effects across counties and industries, a fixed effects spatial lag model is considered because of the possible unobserved heterogeneity. As a result, by controlling for individual fixed effects the model becomes

$$y = \rho(I_T \otimes W_N)y + (\iota_T \otimes \alpha) + X\beta + \varepsilon, \quad (5)$$

where α is Nx1 vector of individual fixed effects, with the constraint that $\alpha' \iota_N = 0$, and

$E[\varepsilon' \varepsilon] = \sigma_\varepsilon^2 I_{NT}$.

The demeaned form of the Equation (4) is obtained by subtracting the average of each cross-sectional unit computed over the time dimension. As a result, the individual fixed effects and the constant term are wiped out from the model and this can be expressed as:

$$Q_{NT} y = \rho (I_T \otimes W_N) Q_{NT} y + Q_{NT} X \beta + Q_{NT} \varepsilon, \text{ (6)}$$

Where $Q_{NT}$ the demeaning factor with dimension NTxNT is expressed as:

$$Q_{NT} = I_{NT} - (\iota_T \iota_T' / T \otimes I_N),$$

with ι a vector of ones.

The matrix $Q_{NT}$ is the idempotent, so the variance of the error becomes:

$$E[\varepsilon \varepsilon'] = \sigma_\varepsilon^2 Q_{NT},$$

where $Q_{NT}$ is assumed to be nonsingular.

**4. Data Description**

The study is based on county level data of employment and earnings from farm, nonfarm, retail and manufacturing sectors in Illinois, Iowa, Nebraska, and South Dakota. The data of employment and earnings compound annual growth rate between 2001 and 2011 was collected from the Bureau of Economic Analysis. The data for non-boom period and boom period is based on the compounded annual growth rate between 2001and 2005, and between 2006 and 2011, respectively. The counties are divided into control and treated groups. The list of 27 treated counties from the four states of the Corn Belt in the Midwest is provided in table 1. The treated group has been considered as counties with more than 10% of the total earnings coming from farm sector in 2006. The year 2006 is the pinnacle of the boom period. In other words, corn prices in 2006 have the highest percentage change (52%) between 2000 and 2012 as shown in Figure 2 below. Despite the fact that the percentage change in prices has dropped sharply from 38% to -13% between 2007 and 2009, this decline was followed by another strong increase from -13% to 46% between 2009 and 2010.

Since the boom period is not exempt of a decline in the prices, its impact on employment and earnings will be partially offset by the decrease in corn prices. The data on corn prices comes from NASS/USDA.

[Insert Figure 2 and Table 1]

Descriptive statistics are made available for compound annual growth rate (CAGR) of employment and earnings for 360 counties both for non-boom and boom. The data is organized as a panel set with 360 cross-sections and 2 periods. From Table 2, the average CAGR of farm, manufacturing, and retail earnings increased during the entire period considered in this study, while the average CAGR of farm, manufacturing, and retail employment decreased. The Farm sector had experienced the highest earnings increase(15.25%), while both farm and manufacturing sectors had gone through the highest employment decrease(-1.80%). By the same token, both the average CAGR of non-farm earnings and employment had increased, but the magnitude of earnings (3.25%) is higher than that of employment (0.25%). The other variables in table 2 besides the ones described above are dummies**.**

[Insert Table 2]

## 5. Estimation and Results

The results of the estimation of the equation 1 are provided in table 3. The coefficients of the interaction term non-boom*treated are negative and not significant for both farm earnings and employment. That is, compound annual growth rate of farm earnings and employment of the treated counties decreased respectively by 1.78% and 0.16% during the non-boom period. Similarly, the coefficients of the interaction term boom*treated are negative and not significant for farm earnings, and positive and not significant for farm employment. That is, compound annual growth rate of farm earnings (employment) of the treated counties decreased (increased) by 2.59% (0.01%) during the boom period. As for the state-period dummies, all the coefficients of the state-boom variables are positive but not significant for farm employment. It means that corn prices have some positive impact on farm employment at the state level during the boom period. In contrast, all the coefficients of the state-non-boom variable are negative and significant for farm employment. That is, corn prices have strong negative impact on farm employment at state level during the non-boom period. However, all the coefficients of state-period variables are negative for Farm earnings in both boom and non-boom periods.

[Insert Table 3]

In order to get more insight about the boom period, we estimate the difference in difference equation which emphasizes the impact of the corn prices during the boom. The estimation results are shown in table 4. The coefficients of the boom variable are positive and significant for both farm employment and earnings. During the boom, the positive growth rates of farm employment and earnings are 3.38% and 28.52% respectively. However, there is negative impact on both farm earnings and farm employment for the treated counties. As for the coefficients of boom – treated variable the sign are unchanged from the results of the equation1.

[Insert Table 4]

The innovative part of this study is to consider the spillover effects across non-farm industries in both source and neighboring counties. We consider the spatial dependence parameter to account for spatial spillover effects. The estimation results of the fixed effect spatial autoregressive model from Equation 6 are presented in Table 5. This estimation was conducted using the fitted value of employment and earnings from the difference in difference equation as explanatory variables. The reason for doing so is that the impact of the boom period was more appealing in difference in difference equation than in Black's equation. The dependent variables are the compound annual growth rate of earnings and employment of non-farm, retail and manufacturing industries. The spatial weight matrix was constructed by recording the adjacent counties for each county of the four states. The diagonal elements of the weight matrix are zeros because one county cannot be adjacent to itself. Also, the weight matrix is standardized. The coefficient $\beta$ from the equation 6 represents the impact of farm employment and earnings on the employment and earnings of the non-farm, retail and manufacturing sectors. The coefficient $\rho$ describes the spatial effect of non-farm, retail and manufacturing employment and earnings on the same sectors in the neighboring counties under the influence of the boom from the farm sector. We see from table 5 that the spillover effects of the farm employment on the non-farm, retail and manufacturing employment in the source counties are negative and significant. That is 1% increase of employment in the farm sector due to corn price boom causes a decline of 0.07% in non-farm sector, 0.03% in retail sector and 0.2% manufacturing sector. In other words, the boom in farm sectors causes labor to move from the local sectors to farm sector. As a consequence, relying on the spatial spillover effects described by $\rho$, we see that 1% increase in the local sectors in the source counties lead to 0.09% increase in the non-farm sector, 0.02%

decrease in the retail and 0.33% increase in the manufacturing sectors in the neighboring counties. The spatial dependence of employment in the manufacturing sector is stronger than that of the other sectors. With respect to the non-farm and retail earnings, they decreased respectively by 0.03% and 0.02% due 1% increase in farm earnings under the influence of the boom. Also, the spatial spillovers of employment and earnings from the local sector in the source counties to the local sectors in the neighboring counties are positive and strong in both non-farm and manufacturing sectors. In contrast, the negative and significant spatial spillover effect is found in the retail sector.

[Insert Table 5]

## 6. Conclusion and further research

Figure 1 shows a sharp increase in the corn prices from 2005 until present. At glance, one could consider this increase as a boom but after close examination of the corn prices through the percentage change, we found that corn prices have decline dramatically between 2006 and 2009 before taking up in 2010. Since the boom is mingled with some busts, it is hard to capture only its impact on employment and earnings.

## 7. References

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## 8-Appendix

**Figure 1: National Corn prices, 1850-2011**

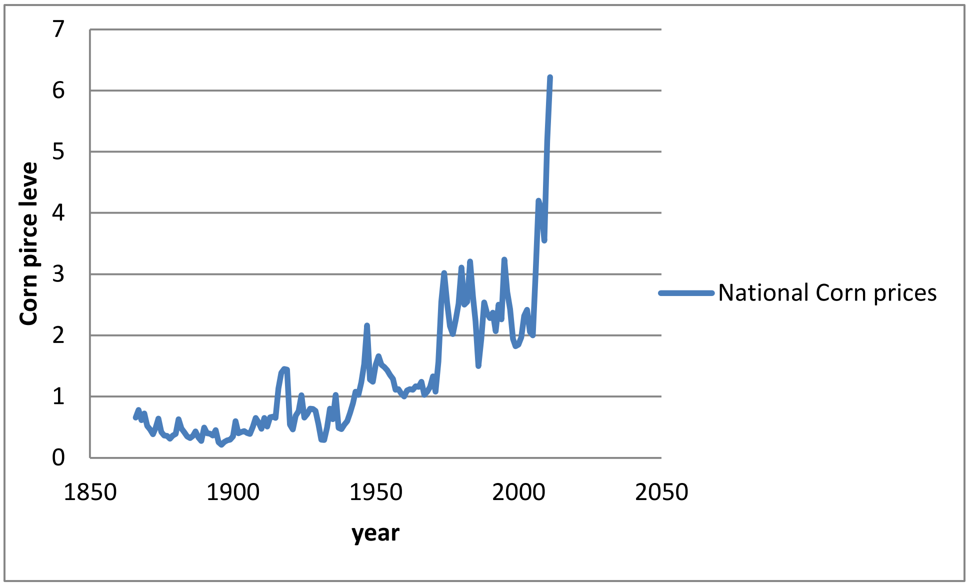
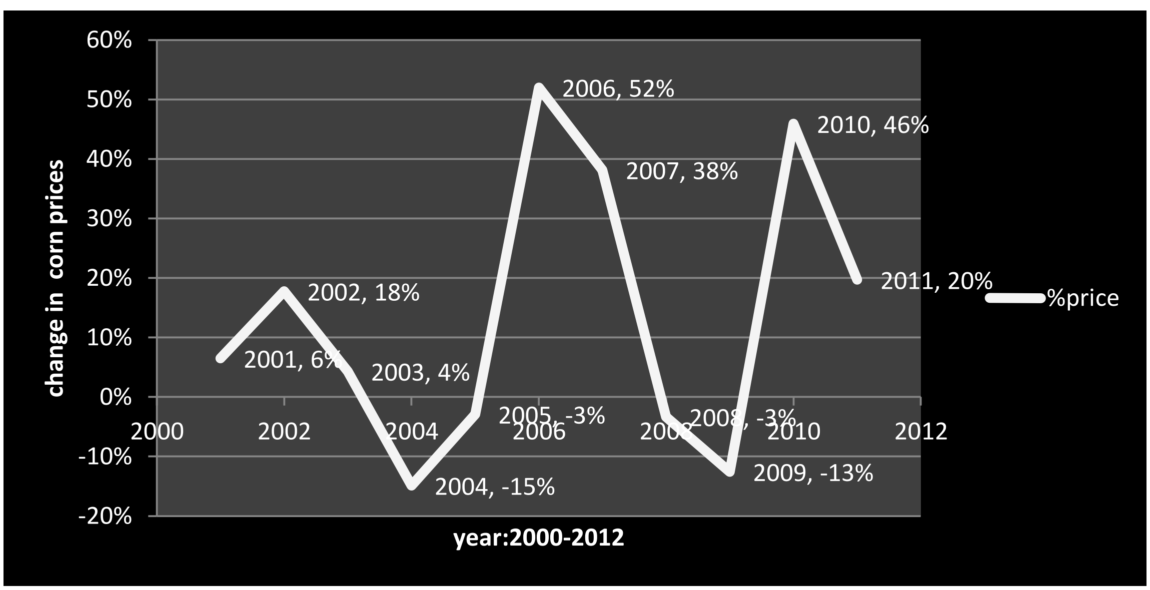



**Figure2: Corn prices in percentage change**




Source: NASS/ USDA

**Table 1: List of the Treated Counties**

| Illinois | Iowa | Nebraska | South Dakota |
|---|---|---|---|
| Alexander, IL | Appanoose, IA | Arthur, NE | Aurora, SD |
| Calhoun, IL | Iowa, IA | Blaine, NE | Davison, SD |
| Effingham, IL | Johnson, IA | Harlan, NE | Lyman, SD |
| Jo Daviess, IL | Jones, IA | Howard, NE | Meade, SD |
| Lee, IL | Keokuk, IA | Loup, NE | Potter, SD |
| Macon, IL | Lyon, IA | Phelps, NE | |
| McDonough, IL | Montgomery, IA | | |
| Warren, IL | | | |
| Winnebago, IL | | | |

**Table 2: Descriptive Statistics**

| Variables | Mean | Std.Deviation | Minimum | Maximum |
|---|---|---|---|---|
| **Earnings** | | | | |
| Farm | 15.25 | 18.38 | -45.97 | 171.67 |
| Non-Farm | 3.25 | 2.70 | -11.44 | 23.58 |
| Manufacturing | 1.97 | 8.60 | -30.96 | 77.32 |
| Retail | 1.73 | 4.48 | -13.55 | 49.06 |
| **Employment** | | | | |
| Farm | -1.80 | 2.87 | -12.89 | 3.31 |
| Non-Farm | 0.25 | 1.69 | -7.30 | 15.60 |
| Manufacturing | -1.80 | 5.75 | -27.30 | 32.06 |
| Retail | -0.79 | 2.61 | -11.38 | 25.83 |
| Treated | 0.08 | 0.27 | 0 | 1 |
| N-Boom*Treated | 0.04 | 0.19 | 0 | 1 |
| Boom*Treated | 0.04 | 0.19 | 0 | 1 |
| State year dummies | | | | |
| N =720 | | | | |

Compounding annual growth rate between 2001 and 2005 (non-boom)

Compounding annual growth rate between 2006 and 2011 (boom)

**Table 3: Black's Approach**

| Dependent Variables | Farm Emp. | Farm Earnings |
|---|---|---|
| N-boom*Treated | -0.16 (-0.70) | -1.78(-0.53) |
| **Boom*Treated** | **0.01 (0.06)** | **-2.59(-0.77)** |
| IL N-boom | -5.26 (-4.45)* | -35.06 (-2.04)* |
| IL boom | 0.67 (0.57) | -29.33(-1.70) |
| IA N-boom | -3.83 (-3.24)* | -24.09(-1.40) |
| IA boom | 1.29 (1.09) | -30.79(-1.79) |
| NE N-boom | -4.62 (-3.91) | -23.78(-1.38) |
| NE boom | 0.68 (0.58) | -23.05(-1.34) |
| SD N-boom | -3.38 (-2.85)* | -28.53(-1.65) |
| SD boom | 0.23 (0.19) | -8.30(-0.48) |
| Constant | -1.49e-13(-0.00) | 41.51(2.42)* |
| N=720 | $R^2$ = 0.83 | $R^2$= 0.14 |

**Table 4: Difference in Difference**

| Dependent Variables | Farm Emp. | Farm Earnings |
|---|---|---|
| **Boom** | **3.38(2.85)*** | **28.52(1.65)** |
| Treated | -0.16(-0.70) | -1.78 (-0.53) |
| **Boom*Treated** | **0.17(0.54)** | **-0.81(-0.17)** |
| IL N-boom | -1.88(-10.13)* | -6.53(-2.42)* |
| IL boom | 0.67(0.57) | -29.3(-1.70) |
| IA N-boom | -0.45(-2.43)* | 4.43(1.63) |
| IA boom | 1.30(1.09) | -30.80(-1.79) |
| NE N-boom | -1.23(-6.55)* | 4.74(1.72) |
| NE boom | 0.67(1.18) | -23.04(-1.34) |
| SD N-boom | - | - |
| SD boom | 0.23(0.19) | -8.30 (-0.48) |
| Constant | -3.37 (-23.18) | 12.98(6.11) |
| N=720 | $R^2$ = 0.83 | $R^2$= 0.14 |

**Table 5: Fixed Effect Spatial Autoregressive**

| Dependent Variables | Non-Farm | Retail | Manufacturing |
|---|---|---|---|
| **Employment** | | | |
| Farm Emp. Diff | -0.07(-3.02)* | -0.30(-5.89)* | -0.2(-2.18)* |
| Constant | 0.10(1.52) | -1.34(-7.07) | -1.54(-4.19)* |
| Rho | 0.09(0.87) | -0.02 (-0.20) | **0.33(2.94)** |
| **Earnings** | | | |
| Farm Ear. Diff | -0.03(-1.62) | -0.12(-3.56) | 0.02(0.29) |
| Constant | 1.78(4.04)* | 3.78(6.04)* | 1.02(0.94) |
| Rho | **0.60(7.77)*** | -0.07(-0.67) | **0.35(3.31)*** |
| N=720 | | | |