Local Economic Spillovers of Irrigation from the High Plains Aquifer to the Agricultural and Non-Agricultural Sectors

Kihwan Yu, Kansas State University, kihwanyu@ksu.edu
Nathan P. Hendricks, Kansas State University, nph@ksu.edu
David R. Steward, Kansas State University, steward@ksu.edu

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Kihwan Yu, Nathan P. Hendricks and David Steward
Department of Agricultural Economics, Kansas State University

KANSAS STATE UNIVERSITY

Introduction

- **An important question that has received less attention is how depletion of water resources could impact economic activity beyond the crop sector.**
  - One common approach is to use input-output models (Guerrero et al., 2017), but these models impose restrictive assumptions on economic behavior.
  - An alternative approach is to utilize historical data to econometrically estimate the spillovers (Hornbeck & Keskin, 2015), but considering only short-run effect.
- **We exploit historical changes in economic activity over the High Plains Aquifer compared to counties outside the Aquifer.**
  - We estimate the impacts of access to irrigation on the crop, livestock, agribusiness, and non-agricultural sectors.

Conceptual Framework

- **Local economic spillovers from introduction of irrigation from High Plains Aquifer**

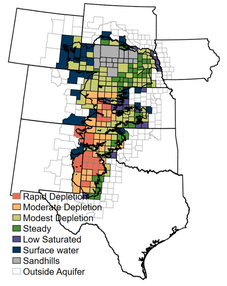
- **Applying Le Chatelier's principle on the profit function of a representative producer in each sector on the aquifer**

$$\frac{d\Pi^{LR}}{d\theta} = \underbrace{p\left(\sum \underbrace{\frac{\partial y}{\partial x}\left[\frac{\partial x}{\partial A}\frac{\partial A}{\partial \theta}+\frac{\partial x}{\partial B}\frac{\partial B}{\partial \theta}\right]}_{Long-Run\ effect} + \underbrace{\frac{\partial y}{\partial A}\frac{\partial A}{\partial \theta}}_{Short-Run\ effects}\right)}_{\text{Total effect on outcome}} - \underbrace{\left(w\frac{\partial x}{\partial \theta}\right)}_{\text{effect on Input}}$$

- **Prediction**
  - **Crop and Livestock sector:**
    - Positive effects by enhancing productivity in the short- and long-run
  - **Non-agricultural sector:**
    - If the share of local industry is relatively large, productivity improves, and margins increase in the short- and long- run.
    - If the share of local industry is relatively small, margins increase in the short-run, but the long-run margins do not remain high because of the GE effect.

Data

- **370 counties either overlying Aquifer or within 100 km**
- **Census of Agriculture (1920-2017)**
  - Historical Census from multiple sources (Gutmann 2005; Haines 2010; Haines 2018)
  - Recent Census data from NASS online
  - Remove Nebraska Sand Hills
- **Non-ag data are from Hornbeck and Keskin (2015) replication package**



Methods

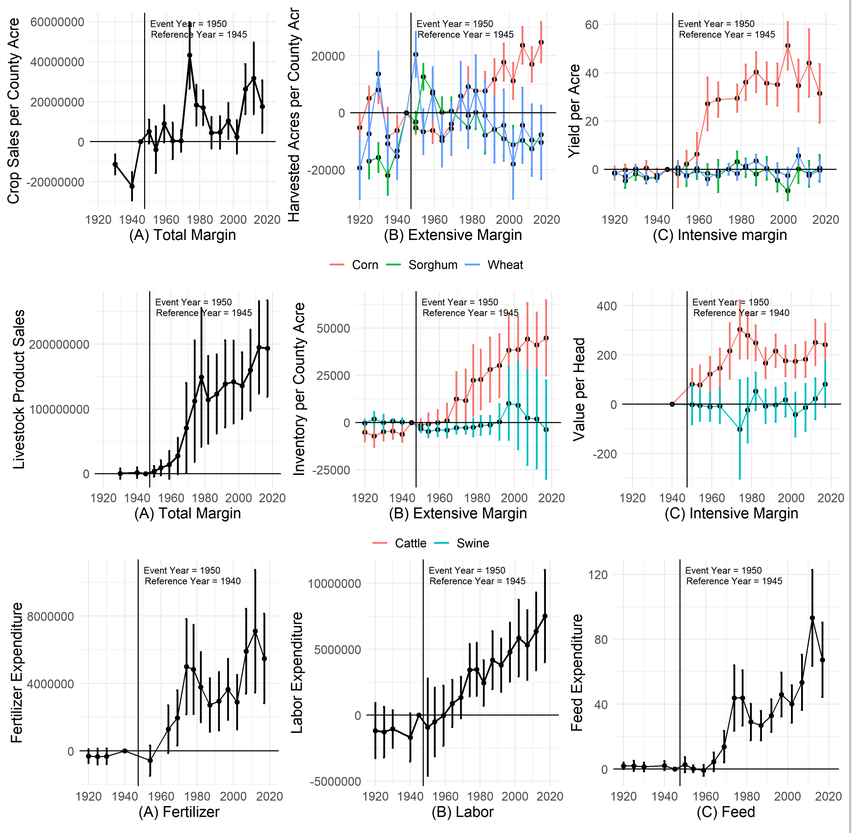
- **Event study with treatment defined as overlying the aquifer and 1950 or later.**

$$y_{it} = \alpha_i + \delta_t + \sum_{m \neq RefYear} \beta^m 1(Year = m) Aquifer_i + \varepsilon_{it}$$

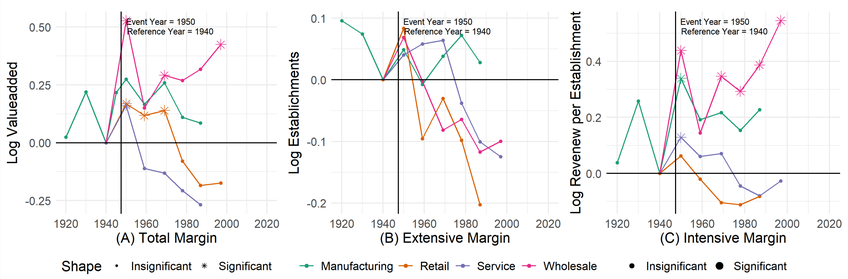
- **Descriptive Heterogeneity Analysis by hydrologic group**

$$y_{it} = \alpha_i + \delta_t + \sum_{m \neq RefYear} \sum_{c} \beta^{m,c} 1(Year = m) Aquifer_i 1(Class_i = c) + \varepsilon_{it}$$

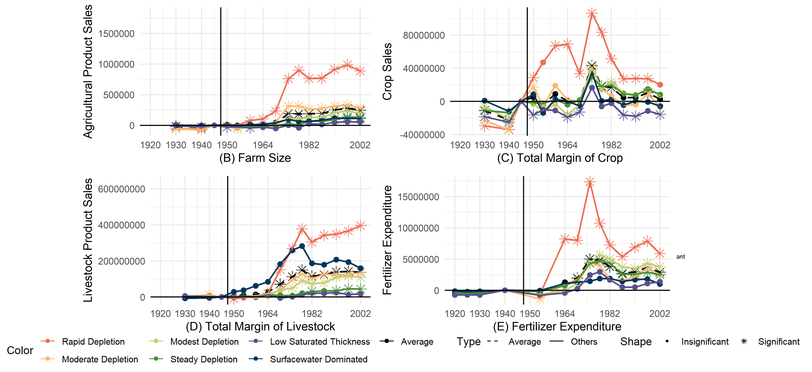
Agriculture Industry Spillovers



Non-Agriculture Industry Spillovers



Descriptive Heterogeneity by hydrologic group



Conclusion

- **Significant spillovers to Agricultural sector and input market**
  - Intensive margins in the crop and livestock sectors improved substantially, but extensive margins in the livestock sector improved substantially.
  - Total margins for both sectors increase.
- **Significant spillovers to Non-agricultural sector**
  - The different share of local industries leads to differences in the effects.
- **The results show that margins increased the most in counties characterized by rapid depletion.**

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