The economic effects of the English Parliamentary enclosures

Leander Heldring     James A. Robinson     Sebastian Vollmer

Stanford, June 2, 2022
Arthur Young’s natural experiment

In 1808 the English agriculturalist Arthur Young stumbled on a natural experiment

In Childersley “divided only by a hedgerow” from Hardwicke, wheat yields were 50% higher

What could explain the difference?

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Introduction:

We study the economic effects of the English parliamentary enclosures (1750-1830):
▶ Enclosure: Assign private property rights to the commons
▶ Enclosure: Consolidate scattered strips into contiguous plots
▶ Two, bottom-up, methods: Informally (unanimity), or through an act of Parliament

Economists: Property rights → development. Evidence inconclusive:
▶ Most famous statement: Hardin’s ‘Tragedy of the Commons’ (Hardin, 1968)
▶ Best evidence: Small estimated effects (Allen, 1982)
▶ Commentators: Enclosure=expropriation (Marx, 1990; Hammond and Hammond, 1911)

Empirical challenges:
▶ Institutional history and detail is complex
▶ Difficult to bring together local measures of enclosure, and economic outcomes
▶ Enclosure is clearly endogenous, need identification strategy
Barton in England
There are three open fields, and several commons
There are the Ings, marsh, cow/horse pastures and 'common wold'

“Barton is a dirty village ... It has neither trade nor manufactures. The arable here lets at 4 shillings per acre, though it is good. The reason is that there is very little ... inclosures”
Sir William Burrell’s Northern Tour, 1758

Barton is enclosed in 1793

Source: Mingay (1997)
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- Barton is enclosed in 1793

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The open fields
Barton (Lincs.) after enclosure

- Barton petitioned Parliament, with a lawyer
- Parliament passed act enclosing Barton

- Enclosure was very expensive, about 13k pounds (value of parish pre-enlosure, 2k)
- Costs were shared among landowners
- Commons disappear, and strips are consolidated
- Survey: Yield doubles, changed crop mix
- Concentration of land in hands of a few people, Like Marmaduke Nelson and William Graburn

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This paper:

Data: We gather data on the English economy between 1750 and 1830:
- About 5,500 enclosure acts, enclosing 1/3 of parishes
- We measure Parliamentary enclosure and economic change across these parishes
- We can not measure unanimous enclosure

We test the most important hypotheses from the case study literature:
- Economic effects: Agricultural yield (Allen, 1982; Overton, 1996)
- Social effects: Land inequality (Marx, 1990; Hammond and Hammond, 1911; Thompson, 1963)

Identification: We exploit the legal process of Parliamentary enclosure:
- What distinguishes Parliamentary enclosure is Parliament
- Use (idiosyncratic) variation in the probability of Parliamentary approval
- Main challenge this solves: Selection into unanimous/Parliamentary enclosure
- May help resolve discrepancy between contemporary and modern estimates
**Preview of main results:**

**Parliamentary enclosure transformed agriculture:**
- Ag. yield higher in enclosed parishes (IV: 44%)
  - Interpretation: Investment incentives and coordination of agricultural practices

**Parliamentary enclosure impacted inequality:**
- Higher land inequality in enclosed parishes (IV: 30%)
  - Interpretation, part I: Common rights of poorer people were less enforceable
  - Interpretation, part II: High costs of enclosure implementation led to ‘selling out’

**Results inconsistent with efficiency of ‘private orderings’:**
- Parliamentary procedure solved inability to coordinate
- Even in small, coherent, communities, like parishes
What was an enclosure:

Parliamentary enclosure was a full reorganization of a parish: (Mingay, 1997, p. 7)

“it meant the extinction of common rights which people held over the farm lands and commons of the parish, the abolition of the scattered holdings in the open fields and a re-allocation of holdings in compact blocks, accompanied usually by the physical separation of the newly created fields .. by the erection of fences, hedges and stone walls”

Two key changes to land ownership structure:
- Assign property rights to common lands
- Consolidate (informal) claims to the open fields
- Other improvements: road building, hedging
Forms of enclosure:

▶ Enclosure could be done by negotiation, and private agreement
▶ In practice, parishes with one or a few large landowners did this
▶ Or, a parish could decide to petition Parliament

Key difference: legislation supersedes previous arrangements, and only 3/4 to 4/5 of landowners need to agree in order to petition Parliament
The Parliamentary enclosure process

**Step 1: Proposal**
- Location: Parish
- Village meeting
- Consent document
- Enclosure Bill to Parliament
- Appoint committee
- Enclosure Bill enacted
- Appoint commissioners

**Step 2: Enactment**
- Location: Parliament
- After consent of Lords

**Step 3: Implementation**
- Location: Parish
- Record of changes, plot layout
- Enclosure award and map
- Consolidation open fields and
  privatization of commons
- Implementation: fields
- Implementation: other
- Roads, ditches, hedges
EXAMPLE OF AN ENCLOSURE ACT

Act for Shifnal, Shropshire. Source: Shropshire county archive
Data:

We assign to each of \( n = 15,000 \) parishes an enclosure indicator:
- We code enclosure from Tate and Turner (1978)
- Main measure: indicator equal to one if parliamentary enclosure occurred between 1750 and 1830

Data sources for outcomes:
- Agricultural yield: Survey underlying Tithe Commutation Act of 1836
- Inequality: Plot level data from Commissioners’ Returns of the same act
- We have data on about 8 million plots, and 800k individuals
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- We have data on about 8 million plots, and 800k individuals
Estimating equation:

\[ Y_p = \beta_0 + \beta_1 \text{enclosed}_p + X_p'\beta_2 + s + \epsilon_p \]

- \( Y_p \) = outcome variable for parish \( p \). We restrict to rural parishes
- \( \text{enclosed}_p \) = indicator equal to one if Parliamentary enclosure in parish \( p \)
- \( X_p \) = vector of covariates
- \( s \) = fixed effects

Covariates:
- Scale: Parish area
- Geography: Elevation
- Location: Latitude, longitude, latitude*longitude
- Regional differences: Four region, London indicators (n=5)
- Soil characteristics: Soil type indicators (n=11)

- \( \epsilon_p \) = Conley standard error, or robust s.e.

Parameter of interest: \( \hat{\beta}_1 \) - measured effect of enclosure
## Enclosure, Yield, and Inequality

**Dependent variable:** ln(Wheat Yield) in bushels per acre

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parliamentary enclosure (yes/no)</td>
<td>0.03 (0.01) [0.007]</td>
<td>0.03 (0.01) [0.007]</td>
<td>0.04 (0.02) [0.007]</td>
<td>0.04 (0.01) [0.007]</td>
</tr>
<tr>
<td>Mean dep. var.</td>
<td>3.05</td>
<td>3.05</td>
<td>0.74</td>
<td>0.74</td>
</tr>
<tr>
<td>SD dep. var.</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>Observations</td>
<td>3641</td>
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<td>4446</td>
<td>4446</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.19</td>
<td>0.32</td>
<td>0.07</td>
<td>0.08</td>
</tr>
</tbody>
</table>

**Scale:** Parish area

**Geography:** Elevation

**Location:** Latitude, longitude, latitude*longitude

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**Interpretation of the estimated effect size**

Starting point: Enclosure was very expensive

- Turner (1989, pp. 60-61), costs: 10 pounds per acre on average
- Mingay (1997, p. 113): For 20 acre farm, costs 4x annual income
- Everyone had to contribute to roads, fences, etc., often in land

Our estimates are in line with historical, but not modern, literature:

- Historical: Arthur Young: 50% increase. Surveys: 66% on average

For inequality, we may underestimate the true effect as well:

- Anecdotally, enclosure resulted in ‘selling out’ (Neeson (1993) case study: 21%)
- Due to high costs and hierarchy of rights:
  - Compensation for customary tax, as much as 20% of land (Turner, 1984)
  - Customary rights were harder to enforce
  - Land given up for compensation was larger share for smaller farmers
Interpretation of the estimated effect size

Our conjecture is that this is due to informally enclosed parishes in the control group:

▶ **Yield**: Yields higher due to purported efficiency gains
▶ **Inequality**: Inequality higher since unanimity easier
▶ Both informally enclosed, unenclosed parishes are control, biasing down estimates

We face essentially a selection on unobservables problem:

▶ Informally enclosed parishes don’t stand to gain from Parliamentary enclosure
▶ Potential gain from enclosure is not observed (as is informal enclosure status!)
▶ We therefore need a source of variation in *Parliamentary* enclosure
Parishes were part of electoral districts called ‘constituencies’:

- Either one of 40 rural constituencies or of 170 ‘boroughs’, two MPS each
- MPs represent hundreds of parishes, franchise below 10% of males
- Parishes therefore have little control over the election of MPs

MPs judged a petition as part of a committee:

- In Parliament, local MPs were assigned to a committee for the enclosure petition
- Committee judged legality of a petition, against ‘standing orders’, 25% fail
- These prescribed, among other things, that all rights were respected
**Identification strategy: Idea**

Idea: Approximate pass rate of committee that would have judged:

- Leave-one-out mean of enclosure passing as an instrument
  (cf. Kling (2006); Dobbie et al. (2018))
- For nearby parishes, which would have had similar committee composition
- Note: Conditioning on petition ‘shifts’ the instrument to London

Construction, for a parish, proceeds in two steps:

- Take the 350 nearest parishes to parish $p$ (can be varied)
- Compute the fraction of successful enclosures within this ‘committee’
- We remove petitioning parish itself
Identification strategy: idea

Under standard assumptions, following this strategy gives us two things:

- A causal interpretation of the estimated effects of enclosures
- LATE: For those parishes considering Parliamentary enclosure

Now: Example to build intuition for Meldreth
Enclosure of Meldreth, Cambridgeshire

(A) Synthetic committee

(B) Instrument construction
<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Tax revenue per capita 1525 (1)</th>
<th>Tax revenue 1525 (2)</th>
<th>Suitability for wheat (3)</th>
<th>Population 1525 (4)</th>
<th>Number of MPs 1700 (5)</th>
<th>Number of nobility 1700 (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leave-one-out pass rate nearby Enclosure Bills</td>
<td>0.005 (0.010)</td>
<td>-0.004 (0.011)</td>
<td>-0.004 (0.030)</td>
<td>0.029 (0.020)</td>
<td>0.001 (0.004)</td>
<td>0.004 (0.012)</td>
</tr>
<tr>
<td>Observations</td>
<td>6791</td>
<td>7581</td>
<td>13919</td>
<td>7581</td>
<td>9339</td>
<td>9339</td>
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<tr>
<td>$R^2$</td>
<td>0.02</td>
<td>0.08</td>
<td>0.50</td>
<td>0.32</td>
<td>0.01</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Scale: Parish area
Geography: Elevation
Location: Latitude, longitude, latitude*longitude
Regional differences: Four region, London indicators (n=5)
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Notes: standardized coefficients
Estimating equations:

We estimate the effect of enclosure in the following system of equations:

Second stage:

\[ Y_p = \delta_0 + \delta_1 \text{enclosed}_p + X'_p \delta_2 + s + \rho_p + \mu_p \]

First stage:

\[ \text{enclosed}_p = \gamma_0 + \gamma_1 S_p^{-d} + X'_p \gamma_2 + s + \nu_p \]

- \( S_p^{-d} = \) Leave-one-out pass rate nearby Enclosure Bills
- To do inference, we report standard errors adjusted for spatial correlation, in most conservative cutoff (about 70km)
- We also report robust standard errors
### The effects of Parliamentary enclosure

**Dependent variable:**

<table>
<thead>
<tr>
<th>In(Wheat Yield) in bushels per acre</th>
<th>Gini (land value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
</tbody>
</table>

**Panel I: IV estimates**

<table>
<thead>
<tr>
<th>Parliamentary enclosure (yes/no)</th>
<th>0.48</th>
<th>0.45</th>
<th>0.16</th>
<th>0.22</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.31)</td>
<td>(0.14)</td>
<td>(0.08)</td>
<td>(0.10)</td>
</tr>
<tr>
<td></td>
<td>[0.09]</td>
<td>[0.08]</td>
<td>[0.04]</td>
<td>[0.05]</td>
</tr>
</tbody>
</table>

| Mean dep. var.                   | 3.05 | 3.05 | 0.74 | 0.74 |
| SD dep. var.                     | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations                     | 3641 | 3641 | 4446 | 4446 |

**Panel II: first stage**

| Leave-one-out pass rate nearby Enclosure Bills | 0.58 | 0.58 | 0.77 | 0.68 |
|                                              | (0.16)| (0.14)| (0.15)| (0.15)|
|                                              | [0.06]| [0.06]| [0.07]| [0.07]| |

| Conley F-stat of Excluded Instrument       | 13.27 | 16.38 | 24.88 | 19.77 |
|                                           |      |      |      |      |

**Panel III: Reduced Form**

| Leave-one-out pass rate nearby Enclosure Bills | 0.28 | 0.26 | 0.12 | 0.15 |
|                                              | (0.14)| (0.06)| (0.07)| (0.07)|
|                                              | [0.04]| [0.04]| [0.03]| [0.03]| |

**Scale:** Parish area

**Geography:** Elevation

**Location:** Latitude, longitude, latitude*longitude

**Regional differences:** Four region, London indicators (n=5)

**Soil characteristics:** Soil type indicators (n=11)

<table>
<thead>
<tr>
<th>Vary k</th>
<th>Bandwidth</th>
</tr>
</thead>
</table>
Effect sizes

Our OLS estimates are considerably smaller than our IV estimates:
- Our interpretation: IV downweights informally enclosed parishes
- These parishes are ‘never-takers’ but did experience change due to enclosure

However, IV estimates may be larger than OLS for other reasons:
- Problem: OLS (ATE) and IV (LATE) are typically not comparable
- We decompose the difference between the OLS and LATE into a part that is due to the different *estimand* and everything else
- Standard application of Marginal Treatment Effects (Heckman and Vytlacil, 2005)
Mechanisms

Yield: We test for investment and coordination as mechanisms:
  ▶ Investment: Patenting activity and road improvement
  ▶ Coordination: Adoption of techniques that were known: Turnips and fallowing

Inequality: We test for ‘selling out’:
  ▶ We compute the number of ‘cottagers’ as a fraction of all landowners
### Mechanisms

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Innovation</th>
<th>Coordination</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nr. Agr. Patents</td>
<td>Road quality poor (yes/no)</td>
<td>Turnips grown (acres)</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Enclosed (yes/no)</td>
<td>0.02 (0.01)</td>
<td>-0.11 (0.04)</td>
<td>0.13 (0.04)</td>
</tr>
<tr>
<td></td>
<td>[0.01]</td>
<td>[0.03]</td>
<td>[0.04]</td>
</tr>
<tr>
<td>Observations</td>
<td>13920</td>
<td>5288</td>
<td>2290</td>
</tr>
</tbody>
</table>

**Scale:** Parish area

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**Regional differences:** Four region, London indicators (n=5)

**Soil characteristics:** Soil type indicators (n=11)

Midlands
Discussion

We provide evidence that enclosure led to:

- Increased agricultural yields
- Increase in land value inequality

Results and the history support a fascinating political economy story:

- Prior to 1750-1830 agriculture was not organized efficiently but this was impossible to change politically because
  - People recognized that some rights would dominate others in the division of the commons
  - People anticipated that other traditional rights, like tithes, would be heavily compensated
  - People were liquidity constrained so could not take advantage of the productivity benefits

- The Parliamentary process eliminated the power of the veto players resulting in increased productivity at the expense of higher inequality
THANKS
Additional slides
Different crops (OLS)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>In(Barley Yield) in bushels per acre</th>
<th>In(Oats Yield) in bushels per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Parliamentary enclosure (yes/no)</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td></td>
<td>[0.007]</td>
<td>[0.007]</td>
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<tr>
<td>Mean dep. var.</td>
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<td>3.41</td>
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<tr>
<td>SD dep. var.</td>
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<td>0.18</td>
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<tr>
<td>Observations</td>
<td>2701</td>
<td>2701</td>
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<tr>
<td>$R^2$</td>
<td>0.11</td>
<td>0.18</td>
</tr>
<tr>
<td>Scale: Parish area</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Geography: Elevation</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Location: Latitude, longitude, latitude*longitude</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Regional differences: Region fixed effects (n=4)</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Soil characteristics: Soil type indicators (n=11)</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
### Inequality Measurement (OLS)

**Dependent variable:**
- Gini (land size) (1) (2)
- Gini (land value) (3) (4)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
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<tbody>
<tr>
<td>Parliamentary enclosure (yes/no)</td>
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<td>0.02</td>
<td>0.04</td>
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<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.01)</td>
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<tr>
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<td>[0.006]</td>
<td>[0.006]</td>
<td>[0.007]</td>
<td>[0.007]</td>
</tr>
<tr>
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<td>0.75</td>
<td>0.74</td>
<td>0.74</td>
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<tr>
<td>SD dep. var.</td>
<td>0.18</td>
<td>0.18</td>
<td>0.21</td>
<td>0.21</td>
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<tr>
<td>Observations</td>
<td>4357</td>
<td>4357</td>
<td>4446</td>
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<tr>
<td>( R^2 )</td>
<td>0.04</td>
<td>0.05</td>
<td>0.07</td>
<td>0.08</td>
</tr>
</tbody>
</table>

**Population:** Total number landowners
- N N Y Y

**Scale:** Parish area
- N Y N Y

**Geography:** Elevation
- N Y N Y

**Location:** Latitude, longitude, latitude*longitude
- N Y N Y

**Regional differences:** Region fixed effects (n=4)
- Y Y Y Y

**Soil characteristics:** Soil type indicators (n=11)
- Y Y Y Y
### Drainage and turnpikes (OLS)

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>In(Wheat Yield)</th>
<th>Gini (land value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Parliamentary enclosure (yes/no)</td>
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<tr>
<td>$R^2$</td>
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<td>0.32</td>
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<tr>
<td>Drainage indicator</td>
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<td>Y</td>
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<tr>
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<td>Y</td>
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<tr>
<td>Scale: Parish area</td>
<td>N</td>
<td>Y</td>
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<tr>
<td>Geography: Elevation</td>
<td>N</td>
<td>Y</td>
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<td>Location: Latitude, longitude, latitude*longitude</td>
<td>N</td>
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<td>Regional differences: Region fixed effects (n=4)</td>
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<td>Y</td>
</tr>
<tr>
<td>Soil characteristics: Soil type indicators (n=11)</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
Common support

(A) Yield

(B) Inequality
**Robustness to \( k \) (IV)**

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>In(Wheat Yield) in bushels per acre (1)</th>
<th>Gini (land value) (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.447*** (0.116)</td>
<td>0.218*** (0.073)</td>
</tr>
<tr>
<td>50</td>
<td>0.447*** (0.133)</td>
<td>0.218** (0.098)</td>
</tr>
<tr>
<td>70</td>
<td>0.447*** (0.137)</td>
<td>0.218** (0.105)</td>
</tr>
<tr>
<td>100</td>
<td>0.447*** (0.139)</td>
<td>0.218** (0.108)</td>
</tr>
</tbody>
</table>

*Scale*: Parish area \( Y \) \( Y \)

*Geography*: Elevation \( Y \) \( Y \)

*Location*: Latitude, longitude, latitude*longitude \( Y \) \( Y \)

*Regional differences*: Region fixed effects (n=4) \( Y \) \( Y \)

*Soil characteristics*: Soil type indicators (n=11) \( Y \) \( Y \)
### Robustness to Conley cutoff (IV)

<table>
<thead>
<tr>
<th>Neighbors</th>
<th>ln(Wheat Yield) in bushels per acre (1)</th>
<th>Gini (land value) (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>0.469***</td>
<td>0.164*</td>
</tr>
<tr>
<td></td>
<td>(0.147)</td>
<td>(0.091)</td>
</tr>
<tr>
<td>300</td>
<td>0.463***</td>
<td>0.192**</td>
</tr>
<tr>
<td></td>
<td>(0.142)</td>
<td>(0.094)</td>
</tr>
<tr>
<td>350</td>
<td>0.447***</td>
<td>0.218**</td>
</tr>
<tr>
<td></td>
<td>(0.137)</td>
<td>(0.105)</td>
</tr>
<tr>
<td>400</td>
<td>0.425***</td>
<td>0.240**</td>
</tr>
<tr>
<td></td>
<td>(0.137)</td>
<td>(0.117)</td>
</tr>
<tr>
<td>450</td>
<td>0.424***</td>
<td>0.253**</td>
</tr>
<tr>
<td></td>
<td>(0.140)</td>
<td>(0.125)</td>
</tr>
<tr>
<td>500</td>
<td>0.444***</td>
<td>0.259**</td>
</tr>
<tr>
<td></td>
<td>(0.149)</td>
<td>(0.132)</td>
</tr>
</tbody>
</table>

**Scale**: Parish area  
**Geography**: Elevation  
**Location**: Latitude, longitude, latitude*longitude  
**Regional differences**: Region fixed effects (n=4)  
**Soil characteristics**: Soil type indicators (n=11)
The Midlands (OLS)

- We test our main results in our sample and Allen’s (1982) sample
- His replicate no effect on yield within his sample, but not with more data
- He finds redistribution of surplus to landowners, we find insignificant effect on inequality

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>In(Wheat Yield)</th>
<th>Gini</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Country</td>
<td>Country</td>
<td>Midlands</td>
</tr>
<tr>
<td>Parliament enclosure (yes/no)</td>
<td>0.03 (0.01) [0.007]</td>
<td>0.00 (0.02) [0.020]</td>
</tr>
<tr>
<td>Mean dep. var.</td>
<td>3.05</td>
<td>3.12</td>
</tr>
<tr>
<td>SD dep. var.</td>
<td>0.21</td>
<td>0.15</td>
</tr>
<tr>
<td>Observations</td>
<td>3641</td>
<td>275</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.32</td>
<td>0.09</td>
</tr>
</tbody>
</table>

**Scale**: Parish area

**Geography**: Elevation

**Location**: Latitude, longitude, latitude*longitude

**Regional differences**: Region fixed effects (n=4)

**Soil characteristics**: Soil type indicators (n=11)


