# The Rise and Fall of Pellagra in the American South

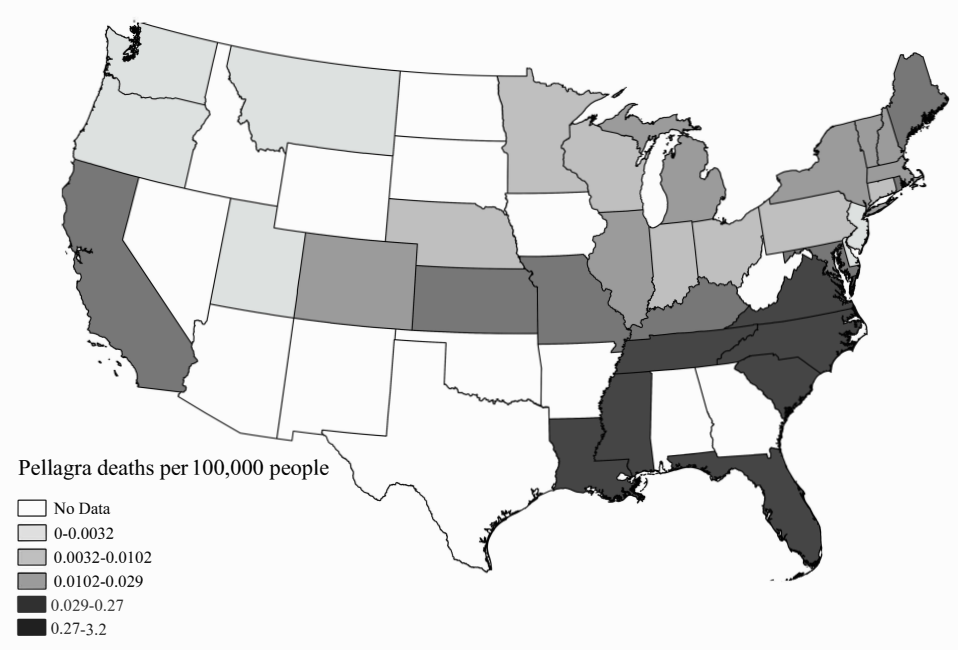
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Ethan Schmick
Werner Troesken

# Introduction – pellagra

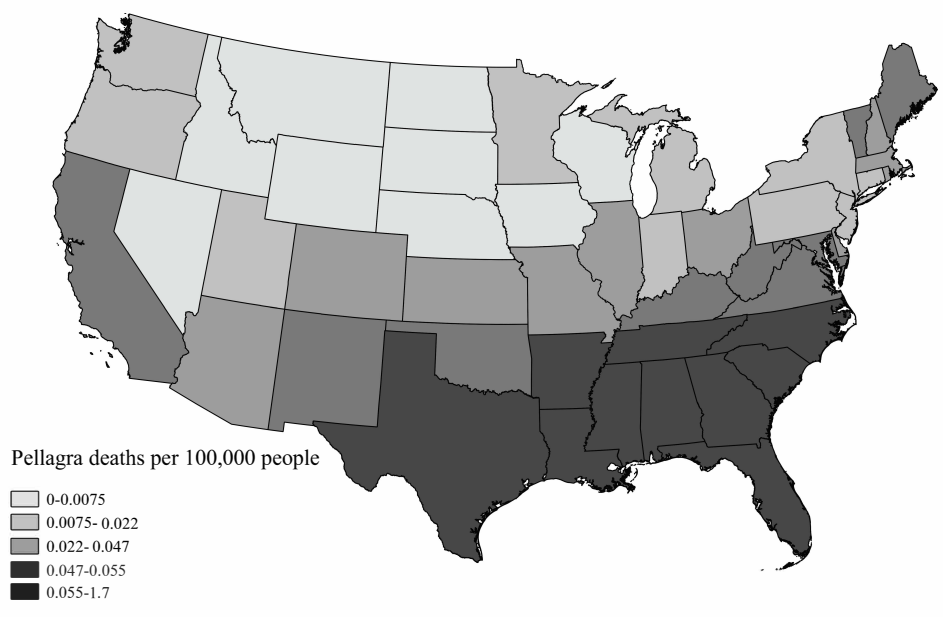
- Pellagra is a disease caused by insufficient niacin consumption.
- Prevalent in the South during the early twentieth century.
- Rise of pellagra: attributed to the South's cotton monoculture (Park et al. 2000; Rajakumar 2000).
- Fall of pellagra: attributed to the discovery of niacin in 1937 and the fortification of bread, flour, and corn products with niacin.

# Introduction – pellagra

Pellagra death rates 1920




Pellagra death rates 1935



# AWFUL DISEASE

## Pellagra is Spreading Rapidly Through the South and West.

## NEW MENACE TO AMERICA

MEDICAL CERTIFICATE OF DEATH

18 DATE OF DEATH May 10 (Month) (Day) 1913 (Year)

17 I HEREBY CERTIFY, That I attended deceased from Apr. 28, 1913, to May 10, 1913

that I last saw him alive on May 10, 1913

and that death occurred, on the date stated above, at 8:20 P. m.

The CAUSE OF DEATH* was as follows:

Acute Pellagra

# MEETING CALLED

### Pellagra Convention Will Meet in Columbia This Week.

## INTEREST WIDESPREAD

**There will Be Hundreds of Physicians From South Carolina and Other States Present—Addresses Will Be Made and the Subject Thoroughly Discussed.**

...r of regret to ...ry. Disney, who ... work in our ...two years, to ...igned and will ...schools along ...ese two ladies ...th and eighth ... will be taken ...in, of Cedar ... of Villisca, ...e school board

... half interest ...urniture stock ... a deal noted ... Invoicing of ...gress, and the ...mmence with-

Mrs. Swyres had Pellagra.

Mention was made last week of the insanity of Mrs. Naomi Swyres, a lady from Oklahoma, who has been visiting relatives at Rippey. Press dispatches on Thursday had the following to say:

"The state board of control received word that an insane woman at Jefferson, Greene county, was being forwarded to the state hospital at Cherokee suffering from pellagra. It was stated she came from Oklahoma and did not have residence in Iowa. This is the first case of pellagra reported in Iowa for a number of years."

Babies' Health Contest.

Previous announcements relating to ...

ABOUT PEOPL...

Mr Frank Ehr... last Saturday for ... onto, Canada. F... last week at Ne... business for his ... company. At the ... business is excee... onto, as well as i... inces. The war ... very seriously up ... all reports.

Mrs. E. B. Stil... for Mt. Pleasant, ... to friends living ...

Mr. and Mrs. ... daughter, of Log... very welcome gue...

The Jefferson Bee Aug. 19, 1914

# Introduction – cotton and pellagra

- Exploit the arrival of the boll weevil in the American South as a plausibly exogenous shock to cotton production.
- The boll weevil was associated with a diversification of crops in the South.
- Counties with high levels of cotton production or pellagra experienced relatively large reductions in pellagra after the arrival of the boll weevil.
- Deaths and death rates for other diseases did not change.
- The groups most likely to be afflicted with pellagra did not migrate out of high cotton producing counties at higher rates.

# Introduction – fortification and pellagra

- Examine the relationship between the discovery of niacin, the passage of fortification laws, and pellagra.

- Both the discovery of niacin and the passage of a state fortification laws contributed to the elimination of the pellagra in the United States.

# Contributions

- Malnutrition can emerge in cash crop societies.
- Poor nutrition could partially explain the South's poor economic performance.
- Our results complement the findings of: Lange et al. (2009), Ager et al. (2017), Bloome et al. (2017).

# Pellagra

- Characterized by the four D's: dermatitis, diarrhea, dementia, and death.
- Took about 6 months to develop and would go away in a few months with proper nutrition.
- Prevalent in the South due to the region's distinct diet.





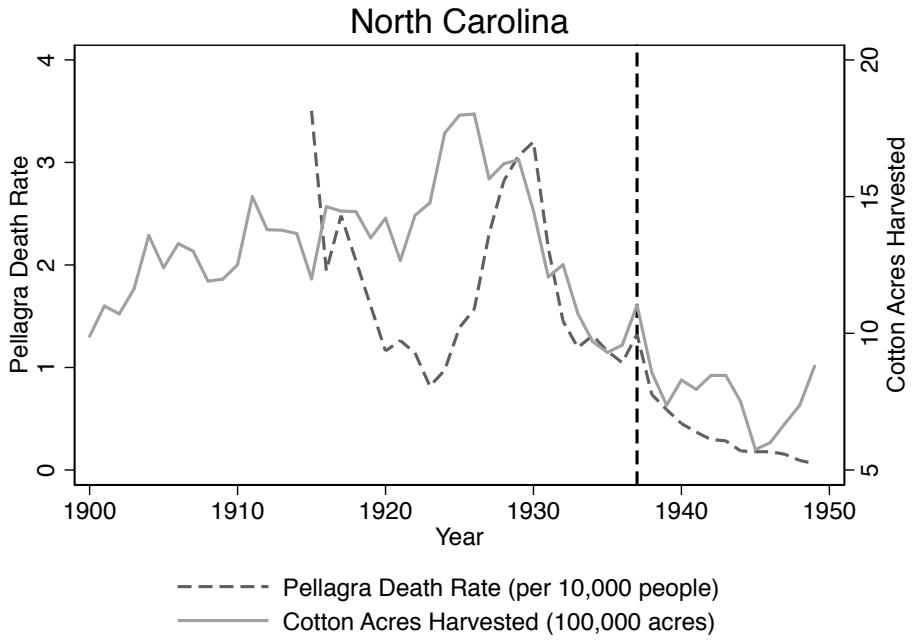


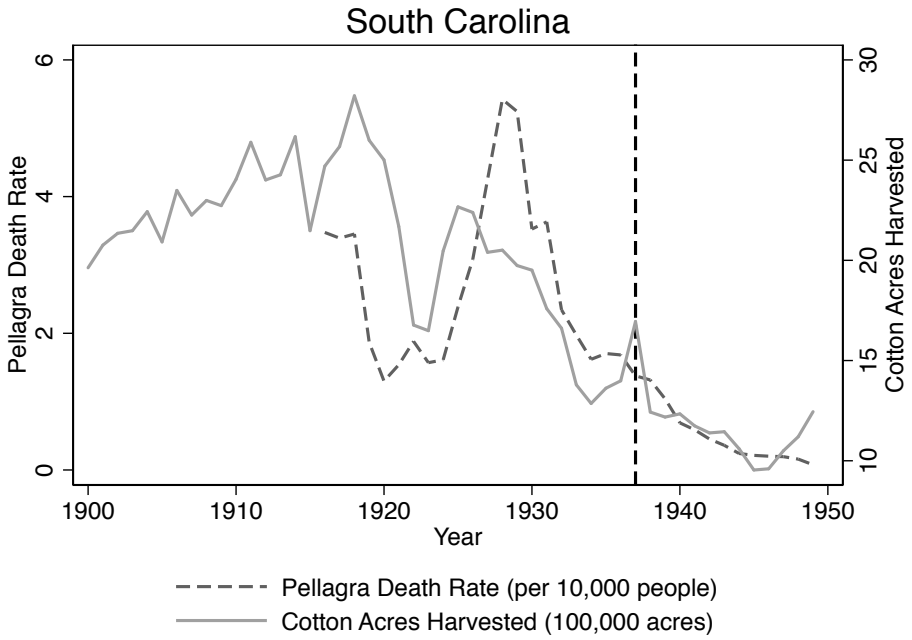
Table 1: Southern diets 1935-1936

| | Non-Southern households | All Southern households | Difference (2) – (1) |
|---|---|---|---|
| | (1) | (2) | (3) |
| Pounds of corn meal per family member used in past week | 0.016 | 0.922 | 0.906*** |
| Pounds of hominy grits per family member used in past week | 0.002 | 0.126 | 0.124*** |
| Pounds of corn meal and hominy grits per family member used in past week | 0.018 | 1.05 | 1.03*** |
| Loaves of white bread per family member used in past week | 1.22 | 0.718 | -0.502*** |
| Pounds of white potatoes per family member used in past week | 2.21 | 1.11 | -1.1*** |
| Dozens of eggs per family member used in past week | 0.43 | 0.367 | -0.063*** |
| Ounces of bottled milk per family member used in past week | 55.92 | 26.56 | 29.36*** |
| Pounds of salt pork per family member used in past week | 0.012 | 0.289 | 0.277*** |
| Total pounds of meat per family member used in past week | 2.07 | 1.94 | -0.13** |
| Observations | 2,672 | 1,040 | |

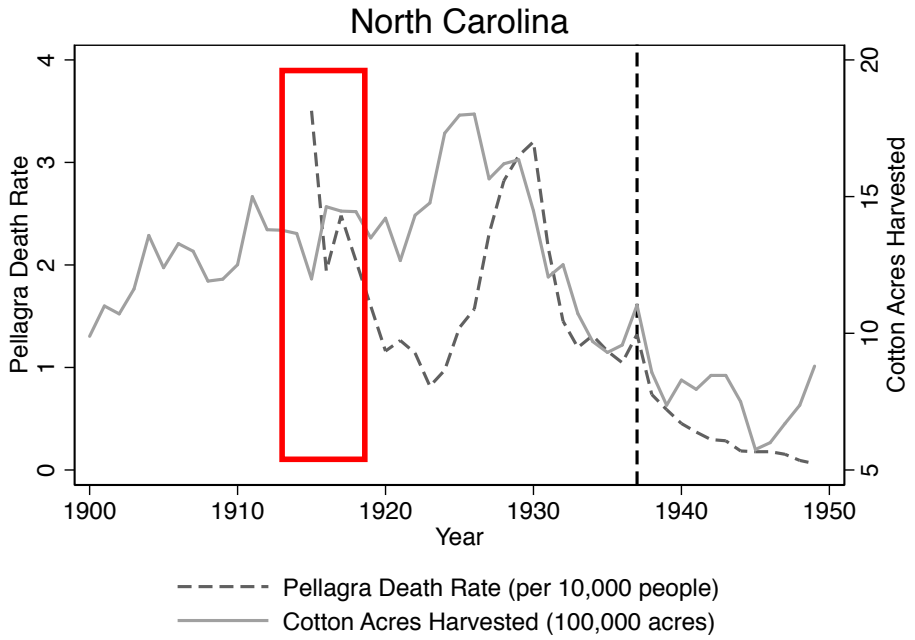
COMPARISON OF THE SUPPLY OF CERTAIN ARTICLES OF FOOD
IN HOUSEHOLDS WITH LOWEST INCOMES AND
IN HOUSEHOLDS HAVING AT LEAST TWO CASES OF PELLAGRA
WITH THAT
IN HOUSEHOLDS WITH HIGHEST INCOMES
(SEE TABLE VII.)

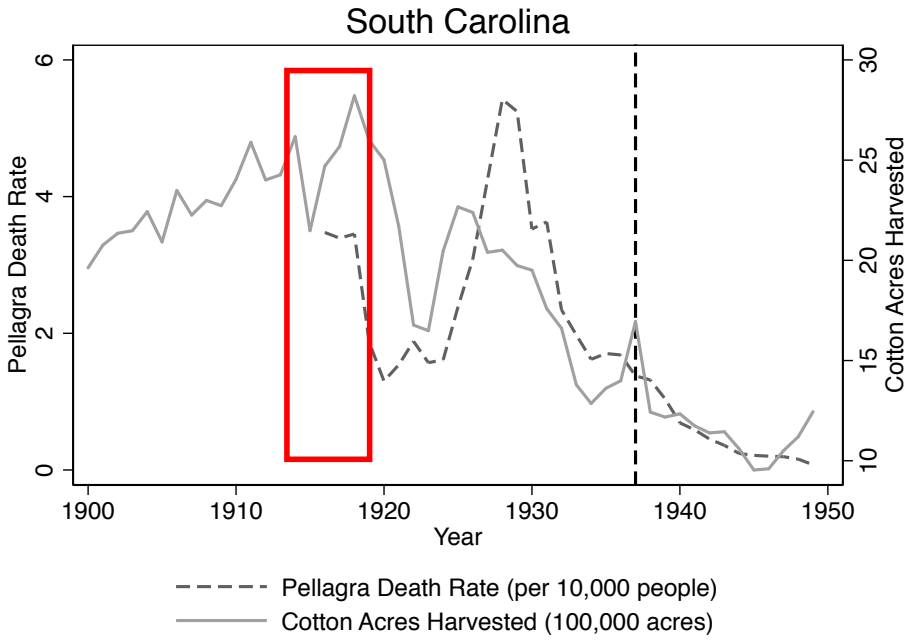
# Pellagra and cotton production



# Pellagra – 1910s



# Pellagra – 1910s

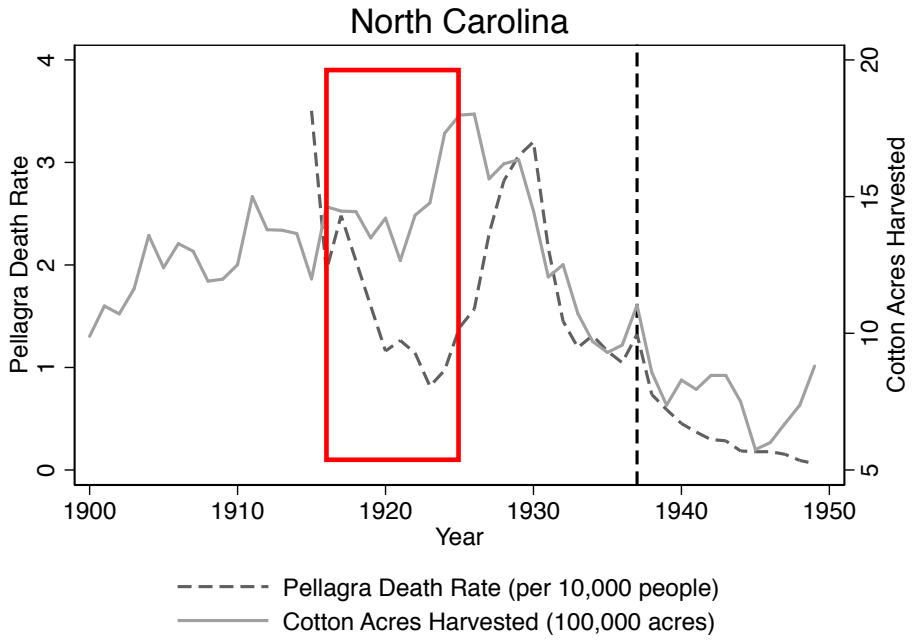
- In the 1910s cotton production and pellagra were high.
- Cotton crowded out local food production and led Southerners to import corn meal from the Midwest.
- Imported cornmeal became less nutritious with the introduction of the Beall degerminator, which removed the germ from the corn.

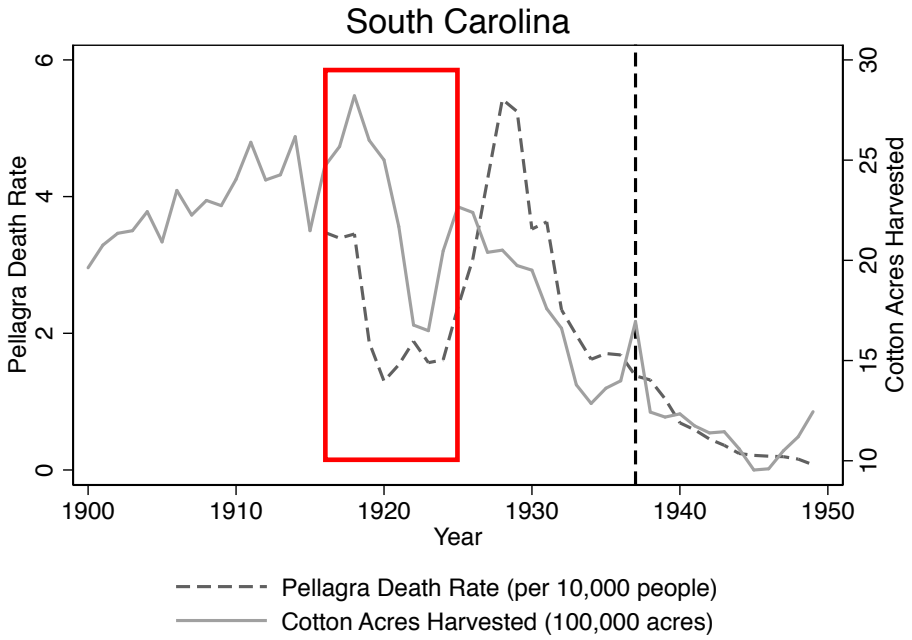
# Dependence on degerminated corn

**Table 1: Corn consumption in six South Carolina mill towns**

| | Shipped cornmeal (percent) | Local cornmeal (percent) |
|---|---|---|
| Consumed daily | 58% | 12% |
| Consumed habitually | 22% | 6% |
| Consumed rarely | 10% | 2% |
| Never consumed | 10% | 80% |
| Observations | 5151 | 5089 |

# Pellagra and the boll weevil

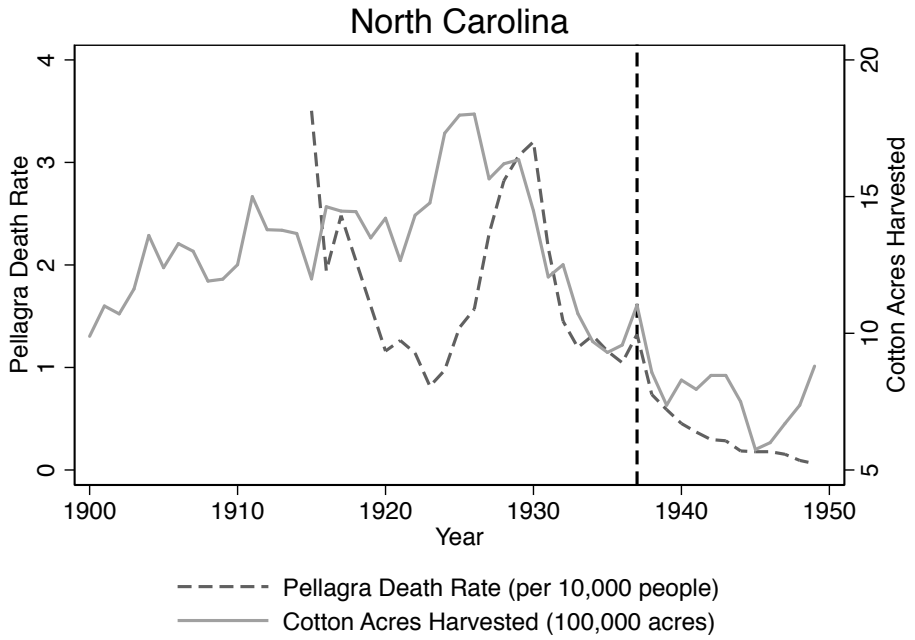


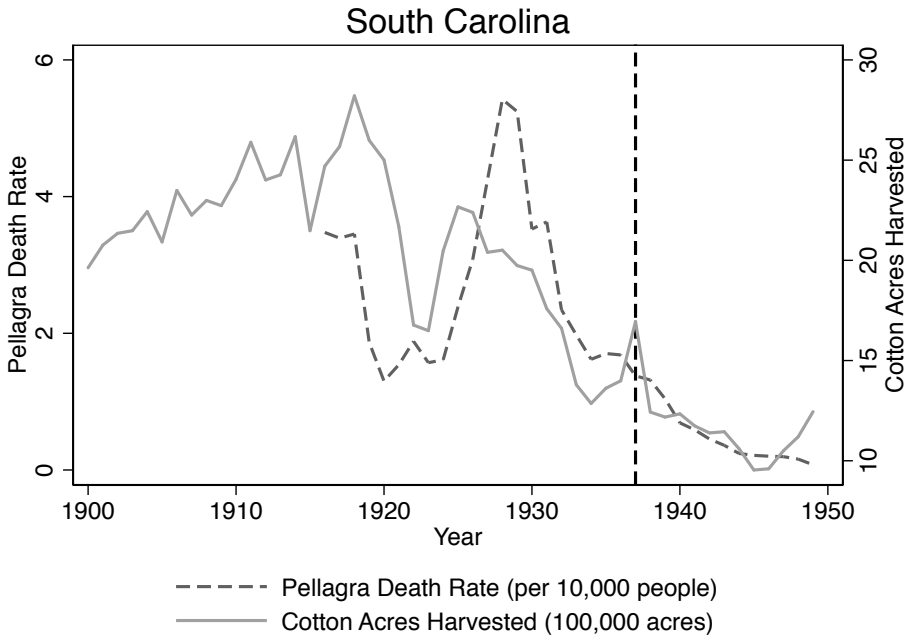



# Pellagra and the boll weevil

- Lange et al. (2009) find that arrival of the boll weevil was associated with a diversification of Southern farmers' crops.
- Increased production of Southern corn, peanuts, and sweet potatoes would have increased niacin consumption.
- Southern corn was not degerminated when it was milled and peanuts and sweet potatoes are rich in niacin.

# Pellagra, the discovery of niacin, and fortification law



# Pellagra, the discovery of niacin, and fortification law

- In 1937 Conrad Elvehjem discovered that niacin cured pellagra.
- In 1937 some bakers began to voluntarily fortify their bread with niacin.
- From 1942-1949 twenty-eight states passed some type of mandatory fortification law leading to the near elimination of pellagra.



# Data

- County pellagra deaths in NC (1915-1949) and SC (1916-1949) from state board of health reports.
- County crop production from the Census of Agriculture.
- Year of boll weevil arrival in a county; year of state law passage.

# Data

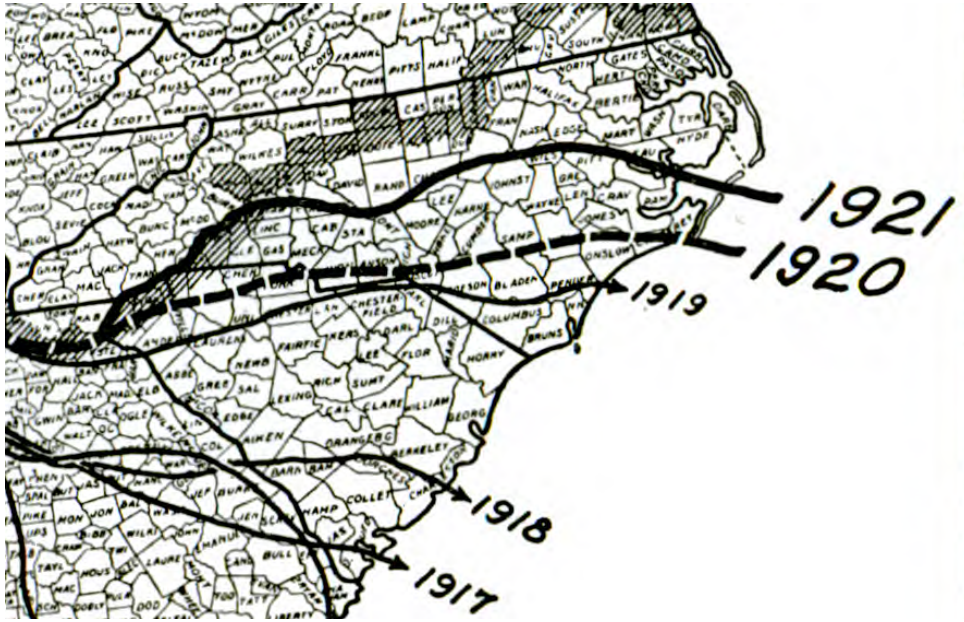
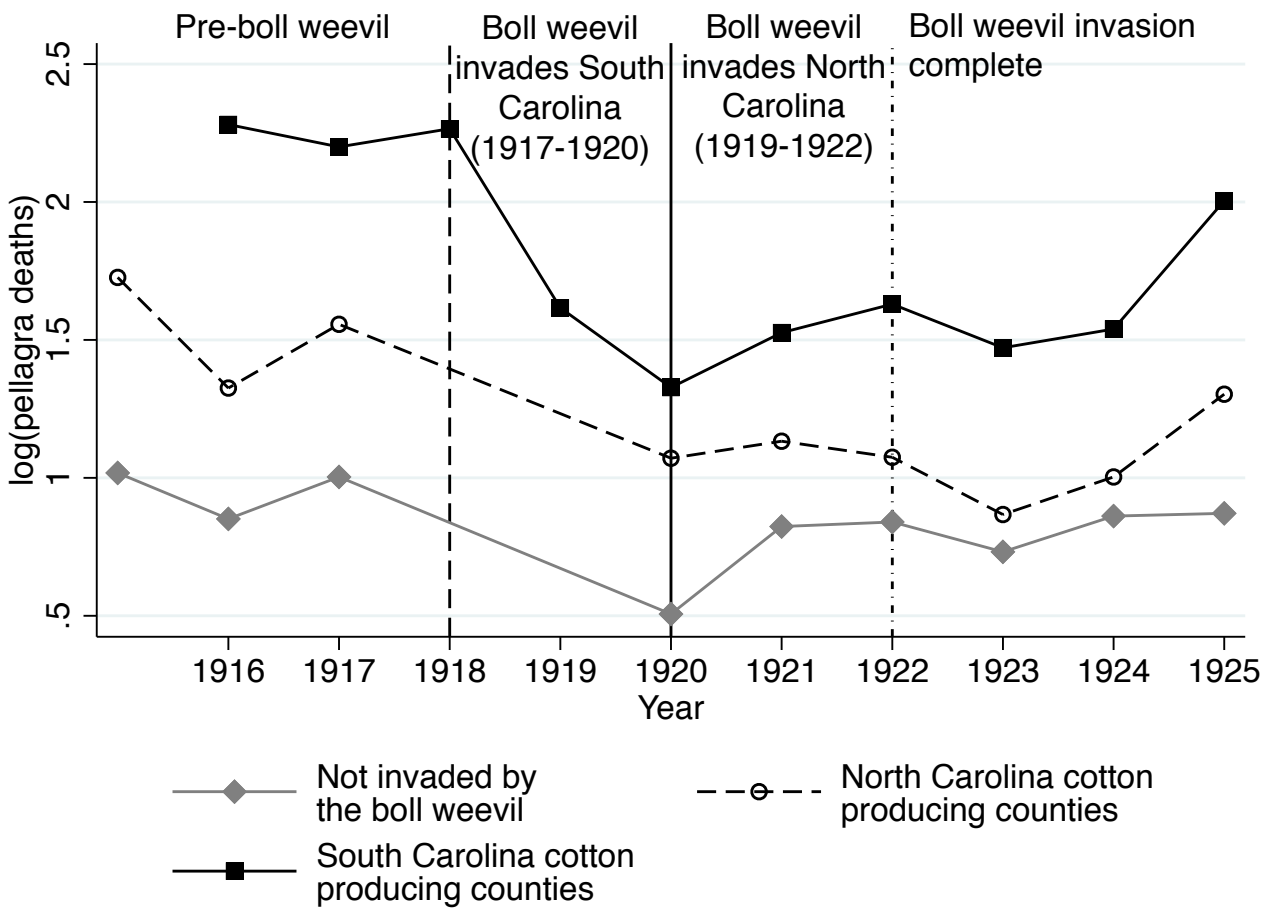



Table A2: Arrival of the boll weevil

| | Number of counties | Cumulative percent of sample |
|---|---|---|
| Year of boll weevil arrival: | | |
| 1917 | 1 | 0.71 |
| 1918 | 7 | 5.67 |
| 1919 | 36 | 31.21 |
| 1920 | 13 | 40.43 |
| 1921 | 29 | 60.99 |
| 1922 | 33 | 84.40 |
| Does not arrive | 22 | 100 |

# Motivating our empirical strategy



# Empirical strategy

- Difference-in-differences:

$$[\text{outcome}]_{ct} = \beta[\text{treatment}]_{ct} \times [\text{intensity}]_{c} + \gamma_{c} + \delta_{t} + \varepsilon_{ct}$$

- Present results using both pellagra deaths and the pellagra death rate as the dependent variable.

- Two county-level intensity measures:

  - Pellagra death rate prior to boll weevil arrival.

  - Cotton acres per capita prior to boll weevil arrival.

# Results – the boll weevil and pellagra

- Pellagra deaths and death rates saw significant decreases after the arrival of the boll weevil.
- Concentrated in high cotton producing or high pellagra counties.
- Robust to: the Great Influenza Pandemic, changing county borders, and population estimates not based on interpolation.

| Dependent variable: | log pellagra deaths | | | |
|---|---|---|---|---|
| Geographic level: | Counties in NC (1915-1925) and SC (1916-1925) | | | |
| | (1) | (2) | (3) | (4) |
| Post boll weevil | -0.283*** | -0.197*** | -0.237*** | -0.202*** |
| | (0.0627) | (0.0687) | (0.0687) | (0.0664) |
| Post boll weevil * high county pre-boll weevil pellagra death rate (1915-1916 average) | | -0.334*** | | |
| | | (0.0943) | | |
| Post boll weevil * high county pre-boll weevil cotton acres per capita (1909) | | | -0.205** | -0.267*** |
| | | | (0.0911) | (0.0907) |

| Dependent variable: | log pellagra death rate | | | |
|---|---|---|---|---|
| | (5) | (6) | (7) | (8) |
| Post boll weevil | -0.235*** | -0.161*** | -0.212*** | -0.185*** |
| | (0.0490) | (0.0525) | (0.0528) | (0.0501) |
| Post boll weevil * high county pre-boll weevil pellagra death rate (1915-1916 average) | | -0.291*** | | |
| | | (0.0709) | | |
| Post boll weevil * high county pre-boll weevil cotton acres per capita (1909) | | | -0.102 | -0.150** |
| | | | (0.0660) | (0.0655) |
| County FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Malaria and urbanization controls | No | No | No | Yes |
| Observations | 1312 | 1312 | 1312 | 1312 |
| Counties | 141 | 141 | 141 | 141 |

# Results – placebo tests

- Deaths and death rates for non-nutrition diseases did not decrease significantly after the arrival of the boll weevil.

- The boll weevil was not associated with overall improvements in health.

Table 5: The boll weevil and other diseases

| Geographic level: | Counties in NC (1915-1925) | | | | | |
|---|---|---|---|---|---|---|
| | (1) log pellagra deaths | (2) log typhoid deaths | (3) log tuberculosis deaths | (4) log measles deaths | (5) log pneumonia deaths | (6) log overall deaths minus pellagra deaths |
| Post boll weevil | -0.200** | 0.0200 | 0.0278 | -0.0130 | 0.0627 | 0.0544** |
| | (0.0791) | (0.0878) | (0.0478) | (0.0780) | (0.0450) | (0.0248) |
| | log pellagra death rate | log typhoid death rate | log tuberculosis death rate | log measles death rate | log pneumonia death rate | log overall death rate minus pellagra deaths |
| | (7) | (8) | (9) | (10) | (11) | (12) |
| Post boll weevil | -0.195*** | 0.0366 | 0.0278 | -0.00323 | 0.0472 | 0.0363 |
| | (0.0622) | (0.0700) | (0.0478) | (0.0570) | (0.0427) | (0.0244) |
| County FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Malaria and urbanization controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 882 | 882 | 882 | 882 | 882 | 882 |
| Counties | 98 | 98 | 98 | 98 | 98 | 98 |

# Results – selective migration of affected groups

- The groups most affected by pellagra might have migrated out of high cotton producing counties at a higher rate than the rest of the population after the arrival of the boll weevil.

- Used the 1910, 1920, and 1930 complete count censuses to count the population of groups most affected by pellagra: children age 2-10 and females age 22-44. Also counted the rest of the population.

# Results – selective migration of affected groups

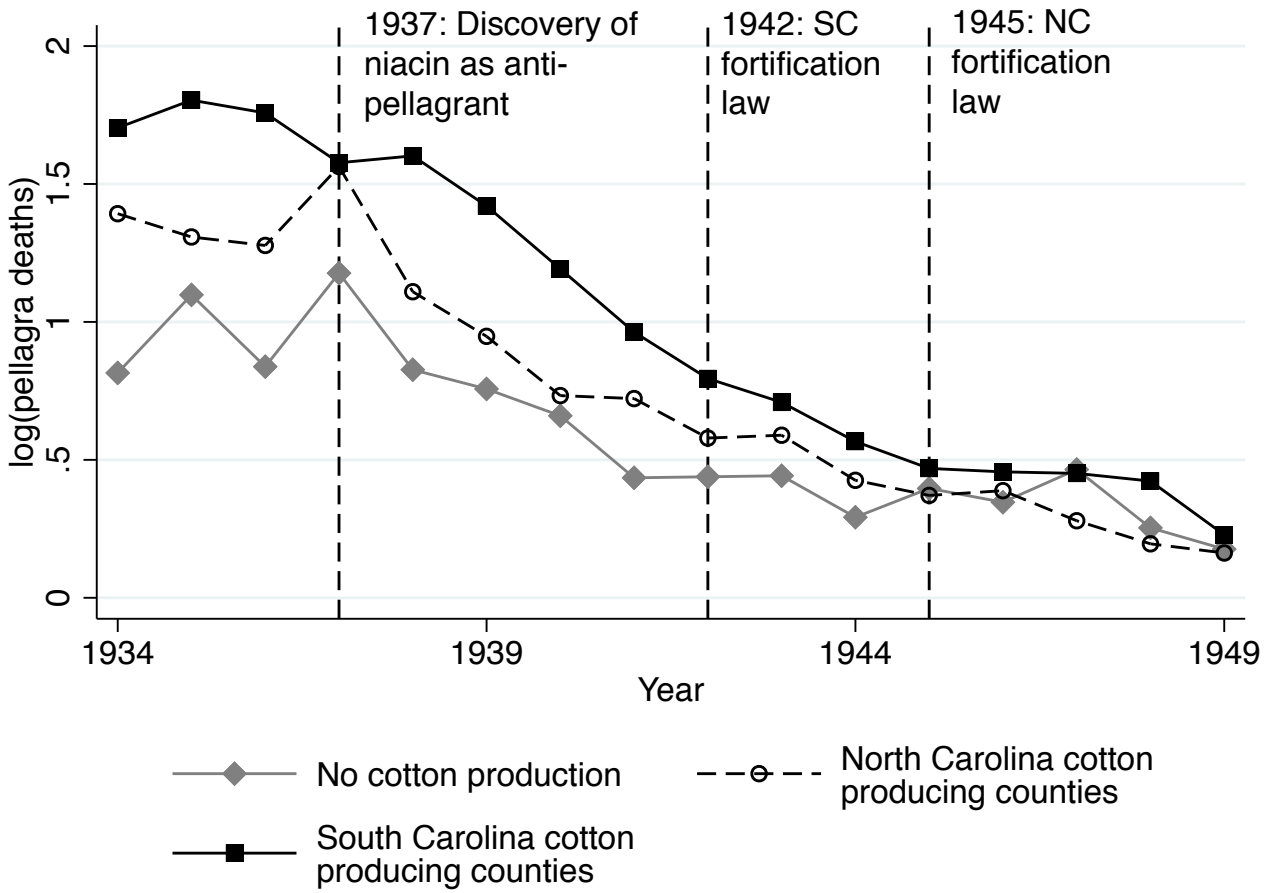
| | (1) | (2) |
|---|---|---|
| Affected group: | Female age 22-44 | Children age 2-10 |
| Post BW * high county pre boll weevil cotton acres per capita (1909) * affected group | -0.0190 | 0.0183 |
| | (0.0133) | (0.0170) |
| Observations | 846 | 846 |
| Counties | 141 | 141 |

See Table A4 for complete results

# Results

- During the early twentieth century pellagra was correlated with cotton production.
- This correlation was broken in 1937 with the discovery of niacin as an anti-pellagrant.

# Motivating the empirical analysis



# Results – discovery of niacin, fortification, and pellagra

- Pellagra deaths and death rates saw significant decreases after the discovery of niacin and after the passage of a fortification law.

- Concentrated in high cotton producing or high pellagra counties.

Table 7: Discovery of niacin and fortification laws – North Carolina and South Carolina

| | log pellagra death rate | | | | | | |
|---|---|---|---|---|---|---|---|
| Time period: | (1934-1941) | | (1938-1949) | | | (1934-1949) | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Post niacin discovery * high pre-niacin pellagra death rate (1928) | -0.147** | | | | | -0.154** | |
| | (0.0688) | | | | | (0.0638) | |
| Post niacin disocvery * high pre-niacin cotton acres per capita (1909) | | -0.0706 | | | | | -0.0668 |
| | | (0.0520) | | | | | (0.0504) |
| Post fortification law | | | -0.0479* | -0.0131 | 0.00371 | -0.0163 | -0.00274 |
| | | | (0.0254) | (0.0303) | (0.0276) | (0.0295) | (0.0270) |
| Post fortification law * high pre-niacin pellagra death rate (1928) | | | | -0.114*** | | -0.101*** | |
| | | | | (0.0319) | | (0.0337) | |
| Post fortification law * high pre-niacin cotton acres per capita (1909) | | | | | -0.132*** | | -0.0925*** |
| | | | | | (0.0314) | | (0.0315) |
| County FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Malaria and urbanization controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1128 | 1128 | 1692 | 1692 | 1692 | 2256 | 2256 |
| Counties | 141 | 141 | 141 | 141 | 141 | 141 | 141 |

# Conclusion

- Pellagra was the most prevalent nutritional disease in the early twentieth century.
- It was associated with the production of cotton.
- We use an exogenous shock to cotton production and show that pellagra deaths and death rates decreased in high cotton producing counties.
- Pellagra was eliminated by the discovery of niacin as an anti-pellagrant.

Table 6: The boll weevil and crops

| | Log cotton yield | Log cotton acres | Log cotton acres per capita | Log tobacco acres | Log tobacco acres per capita |
|---|---|---|---|---|---|
| Geographic level: | Counties in North Carolina and South Carolina (1909, 1919, 1924, 1929) | | | | |
| | (1) | (2) | (3) | (4) | (5) |
| Post boll weevil | -0.0240 | 0.436*** | 0.115*** | 0.679*** | 0.0245*** |
| | (0.0184) | (0.161) | (0.0161) | (0.224) | (0.00879) |
| Post boll weevil * high county pre-boll weevil cotton acres per capita (1909) | -0.0178 | 0.0356 | -0.0821** | -0.431 | -0.0277 |
| | (0.0294) | (0.166) | (0.0409) | (0.453) | (0.0213) |

| | Log corn acres | Log corn acres per capita | Log peanut acres | Log peanut acres per capita | Log sweet potato acres | Log sweet potato acres per capita |
|---|---|---|---|---|---|---|
| Geographic level: | Counties in North Carolina and South Carolina (1909, 1919, 1924, 1929) | | | | | |
| | (6) | (7) | (8) | (9) | (10) | (11) |
| Post boll weevil | 0.00824 | -0.00830 | -0.164 | 0.0103 | -0.112 | -0.00642** |
| | (0.0259) | (0.0126) | (0.193) | (0.00687) | (0.0752) | (0.00260) |
| Post boll weevil * high county pre-boll weevil cotton acres per capita (1909) | 0.0157 | 0.0749*** | 0.666* | 0.0111 | 0.184 | 0.0116*** |
| | (0.0547) | (0.0232) | (0.356) | (0.0118) | (0.123) | (0.00340) |
| County FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Quadratic time trend interacted with share of cotton in total acres harvested in 1909 | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 564 | 564 | 564 | 564 | 564 | 564 |
| Counties | 141 | 141 | 141 | 141 | 141 | 141 |

| | Baseline result from Table 3 | Drop 1918 and 1919 | Drop counties that changed borders | Control for interpolated population/ Adjust for population migration |
|---|---|---|---|---|
| Dependent variable: | log pellagra deaths | | | |
| Geographic level: | Counties in NC (1915-1925) and SC (1916-1925) | | | |
| | (1) | (2) | (3) | (4) |
| Post boll weevil | -0.202*** | -0.244*** | -0.256*** | -0.196*** |
| | (0.0664) | (0.0713) | (0.0689) | (0.0660) |
| Post boll weevil * high county pre-boll weevil cotton acres per capita (1909) | -0.267*** | -0.343*** | -0.241** | -0.280*** |
| | (0.0907) | (0.0983) | (0.105) | (0.0934) |
| Log(interpolated population) | | | | -0.221 |
| | | | | (0.596) |
| Dependent variable: | log pellagra death rate | | | |
| | (5) | (6) | (7) | (8) |
| Post boll weevil | -0.185*** | -0.217*** | -0.230*** | -0.185*** |
| | (0.0501) | (0.0539) | (0.0535) | (0.0502) |
| Post boll weevil * high county pre-boll weevil cotton acres per capita (1909) | -0.150** | -0.200*** | -0.137* | -0.154** |
| | (0.0655) | (0.0708) | (0.0754) | (0.0638) |
| County FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Malaria and urbanization controls | Yes | Yes | Yes | Yes |
| Observations | 1312 | 1226 | 1006 | 1312 |
| Counties | 141 | 141 | 109 | 141 |