



Causal Inference for IR and IPE with Substantive Applications

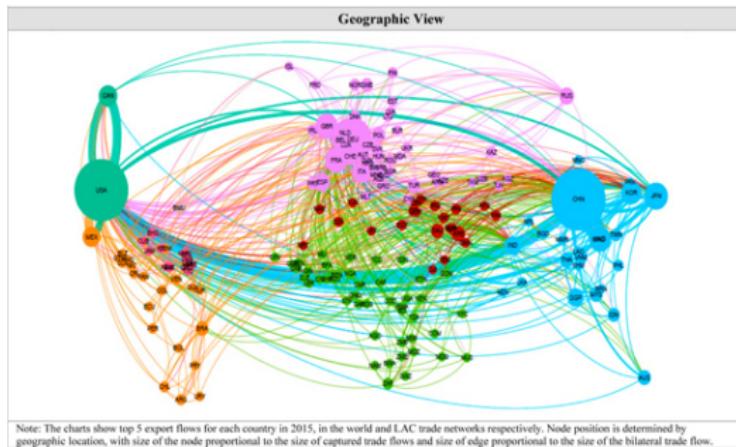
Carlos Felipe Balcazar

MacMillan Center

February, 2024

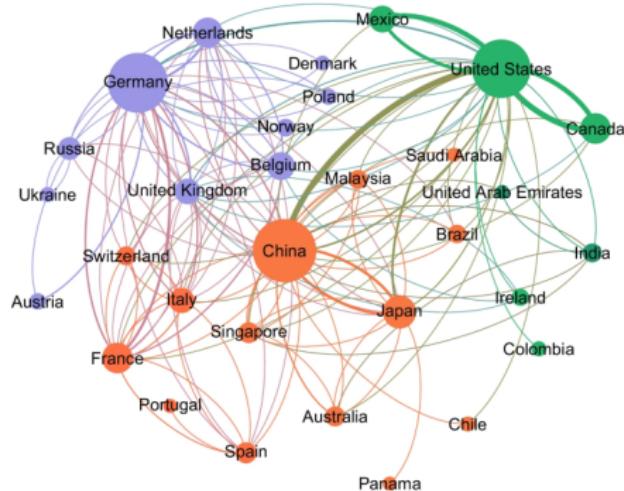
Spatial correlation and interference

“everything is related to everything else, but near things are more related than distant things.” (Tobler)



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Units can be spatially connected

- ▶ Connected in a network or close to each other (any measure).
 - ▶ Recall dyadic clustering.
- ▶ May react similarly to a treatment - spatial correlation.
- ▶ Affected other units behavior - interference (SUTVA).
- ▶ Theoretically: “simultaneous” or sequential best responses.
 - ▶ *I know that you know that I anticipate that you will anticipate..*
 - ▶ First movers trigger actions in other actors (followers).
 - ▶ “Trembling hand mistakes” may generate an “off-path” response.
 - ▶ Shocks can trigger a cascade reaction.

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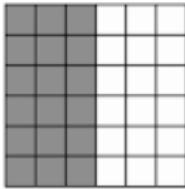
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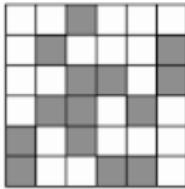
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Spatial correlation

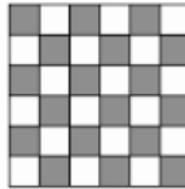
Spatial correlation or network-like correlation



Positive spatial
autocorrelation



No spatial
autocorrelation



Negative spatial
autocorrelation

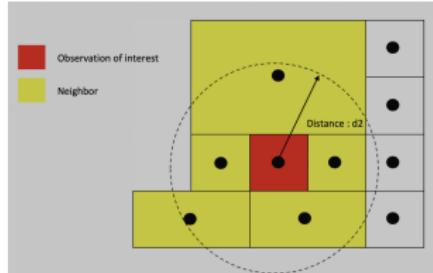
- Units may react similarly to a treatment if they are close enough.

Spatial correlation or network-like correlation

$$I = \frac{N}{W} \frac{\sum_{i=1}^N \sum_{j=1}^N w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^N (x_i - \bar{x})^2}$$

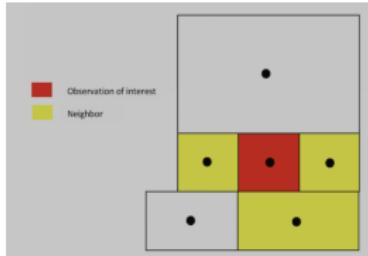
- ▶ Units may react similarly to a treatment if they are close enough.
- ▶ Moran test: relation in a signal among nearby locations in space.
 - ▶ What is distance? How much does neighbor matter?

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 - ▶ What is distance? How much does neighbor matter?
- ▶ Distance is not only 2-D euclidean:
 - ▶ 3-D if there's topography; geographical obstacles; taxi-cab distance.
 - ▶ Google maps transportation time.

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- ▶ Distance is not only 2-D euclidean:
 - ▶ 3-D if there's topography; geographical obstacles; taxi-cab distance.
 - ▶ Google maps transportation time.
- ▶ Recall commensurability!

Spatial correlation or network-like correlation II

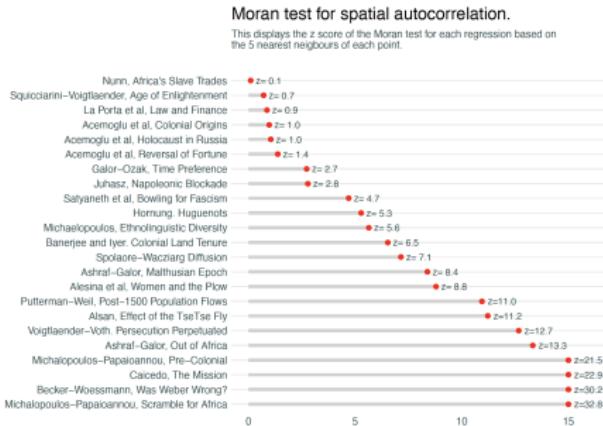
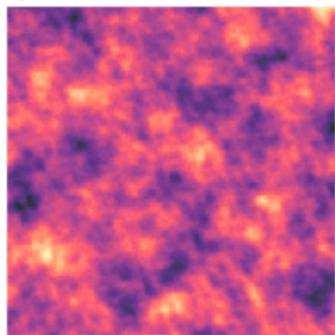


Figure 6: Z scores of Moran tests for spatial autocorrelation in regression residuals.

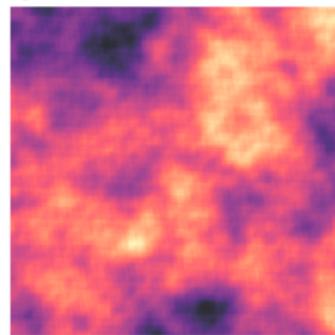
- Spatial noise fits better? (Similar to permutation tests).

Spatial correlation or network-like correlation II

Range=0.1



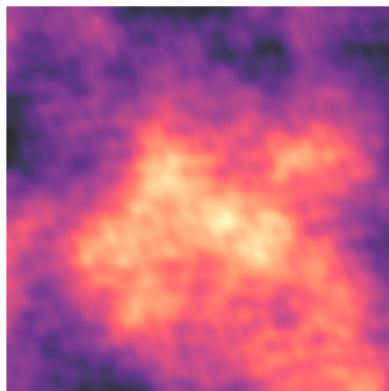
Range=0.25



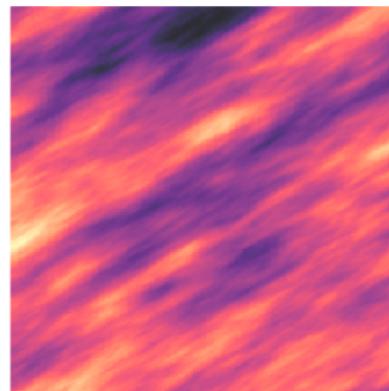
- Spatial noise fits better? (Similar to permutation tests).

Spatial correlation or network-like correlation II

Range=0.5

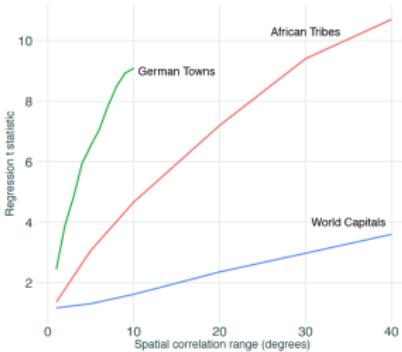


Range=0.5. Anisotropy: ratio=1/4, angle=60



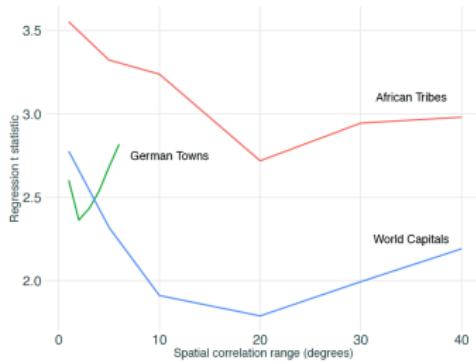
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Spatial correlation or network-like correlation II



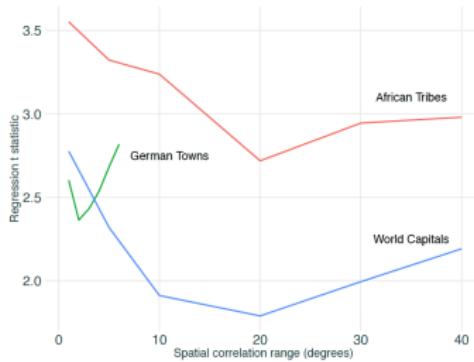
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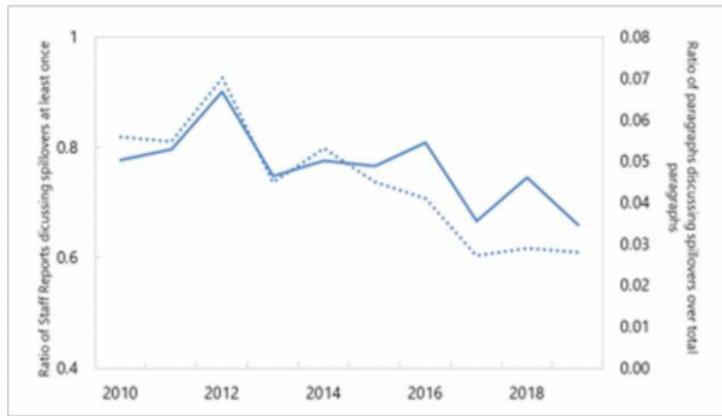


- ▶ Spatial noise fits better? (Similar to permutation tests).
- ▶ Spatial correlation is stronger if distances are smaller.
- ▶ Conley standard errors or spatial HAC.
 - ▶ No optimal procedure to establish bandwidth as in RDD.

Interference and spillovers

A BIG assumption in empirical work: SUTVA

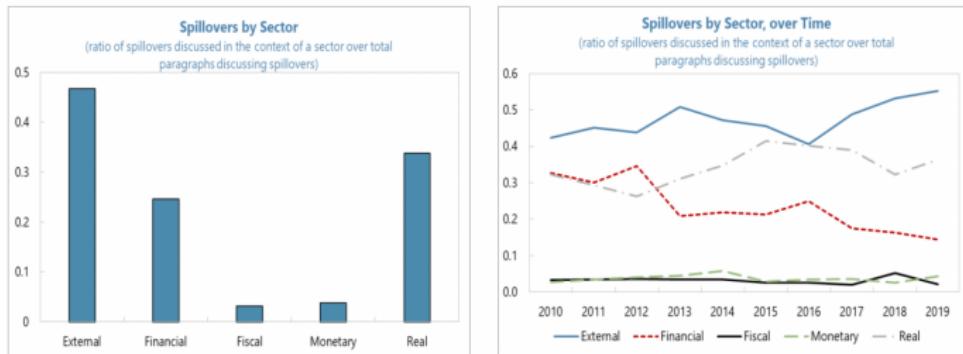
Figure 3. Spillover Mentions Over Time



- ▶ Stable Unit Treatment Value Assumption (SUTVA).
 - ▶ No spillovers; treatment is properly measured; uptake independent.
 - ▶ No strategic reactions.

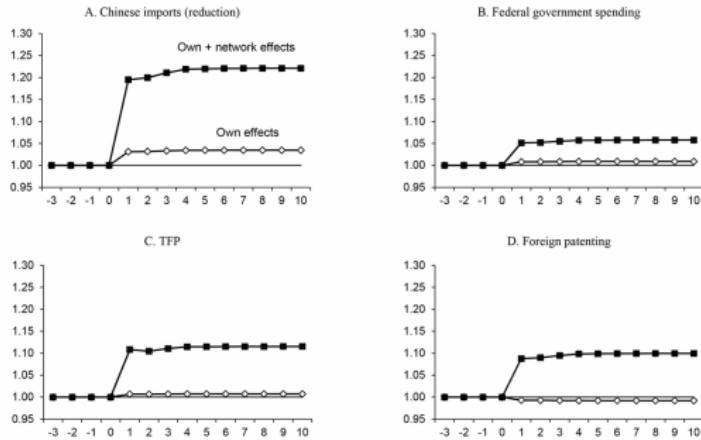
A BIG assumption in empirical work: SUTVA

Figure 6. Spillover Mentions by Sector



- ▶ Stable Unit Treatment Value Assumption (SUTVA).
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► Stable Unit Treatment Value Assumption (SUTVA).

- No spillovers; treatment is properly measured; uptake independent.
- No strategic reactions.

Problematic for IR/IPE

| | | Difference in Mark-Ups (Developed-Developing) | |
|-----------------------------|------|---|--|
| | | Low | High |
| Salience of Labor Practices | Low | <i>Low Treatment Effect</i> (i.e., Plastics/Rubber, Commodities) | <i>Moderate Treatment Effect</i> (i.e., Fabricated Metals, Chemicals) |
| | High | <i>Moderate Treatment Effect</i> (i.e., Garments/Apparel) | <i>Large Treatment Effect</i> (i.e., Computers, Electronics) |

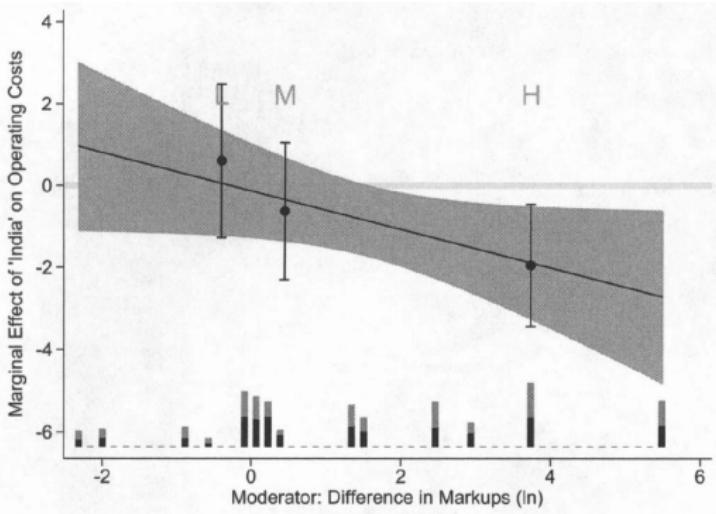
- ▶ Strategic adjustments; gen eq. effects.

Problematic for IR/IPE

G13: Imagine the following scenario: Your business has been contacted by an international consulting company, whose primary job is to connect large multinational companies to suppliers in emerging markets. The consulting company would like to shortlist your company, along with two other companies in your region, as potential suppliers of your product to a large [European/Indian] company that sells primarily to the [European/Indian] market. To be eligible to be included on the shortlist, the consulting company requires that your firm adopt the multinational's Labor Code of Conduct for Suppliers. This Code of Conduct includes greater representation for workers, limits on overtime work, and regulations to protect the health and safety of workers. Adopting the Code of Conduct will allow you the possibility of future orders from this multinational and others like it, but it also will increase your operating costs. Please tell us the maximum amount of adjustments - in terms of their financial costs - that you would be willing to make in order be in compliance with the code of conduct and thereby eligible for the contract. To make this easier, we have listed the costs as a share of your current operating costs:

- ▶ Strategic adjustments; gen eq. effects.

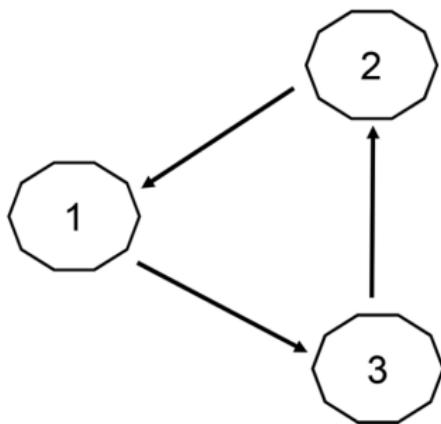
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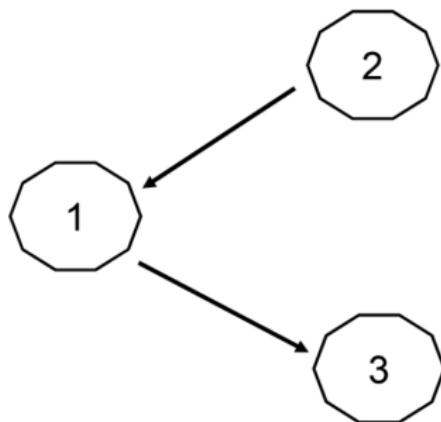
- ▶ Strategic adjustments; gen eq. effects.

Problematic for IR/IPE

A. Complete cycle

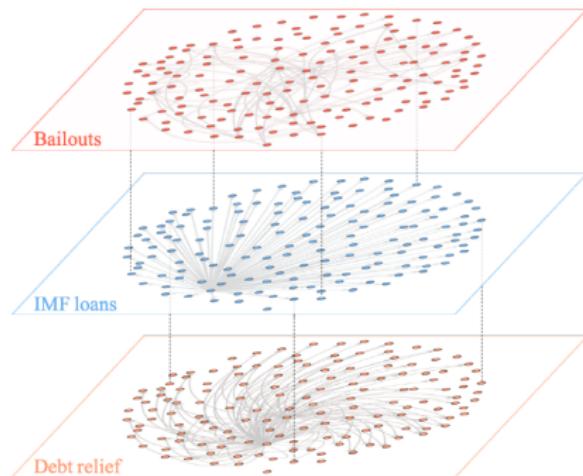


B. Incomplete cycle



- ▶ Strategic adjustments; gen eq. effects.

Problematic for IR/IPE



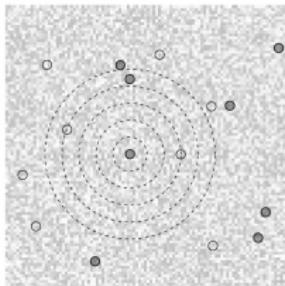
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Problematic for IR/IPE

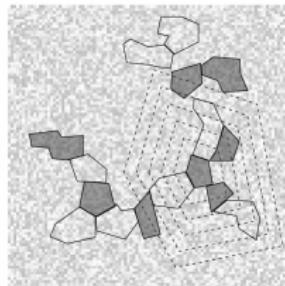
- ▶ Strategic adjustments; gen eq. effects.
 - ▶ Global value chains.
 - ▶ Economic/defense blocks.
 - ▶ International finance.
 - ▶ Behavior in IOs.
 - ▶ Human rights.
- ▶ Where else?

Average Marginilized Effects (AME)

Point intervention



Polygon intervention



- ▶ Focus on centroids and distances between centroids.

Average Marginilized Effects (AME)

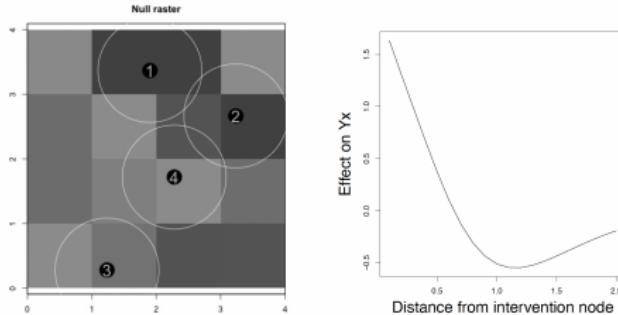
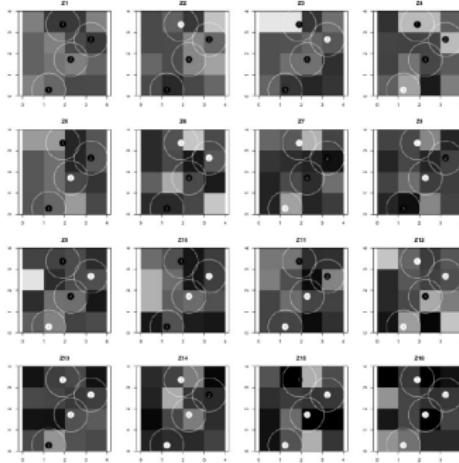


Figure 2: Left: Illustration of a “null raster,” with $N = 4$ intervention nodes (points), none of which are assigned to treatment. The coloring of the raster cells corresponds to outcome levels. White circles around the nodes are circle averages based on the Euclidean distance. Right: Illustration of a possible effect function such that treatments transmit effects non-monotonically in distance. When multiple intervention nodes are treated, these effects accumulate.

- ▶ Focus on centroids and distances between centroids.
- ▶ Treatment effect is non-monotonic function of distance.

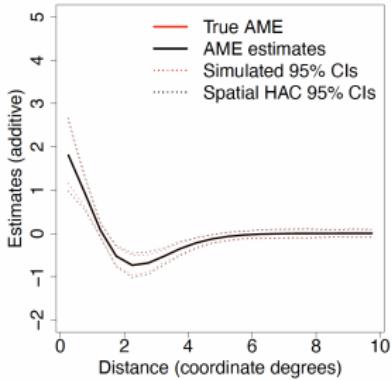
Average Marginilized Effects (AME)



- ▶ Focus on centroids and distances between centroids.
- ▶ Treatment effect is non-monotonic function of distance.
- ▶ TE using permutations on treated nodes given distance.

Average Marginilized Effects (AME)

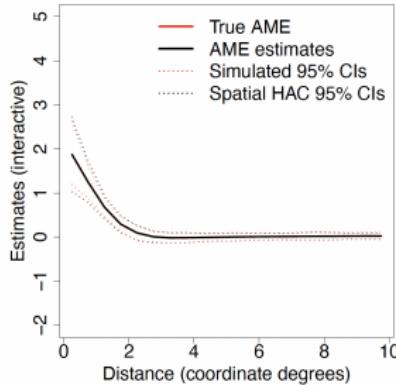
Comparison of CIs (Spatial HAC vs. Simulated)



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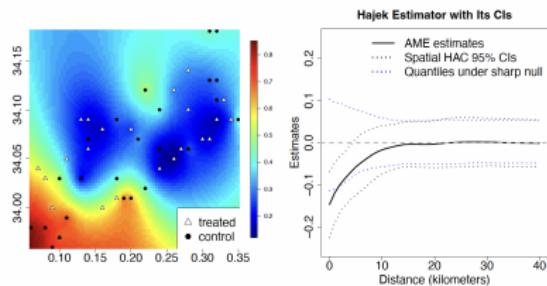
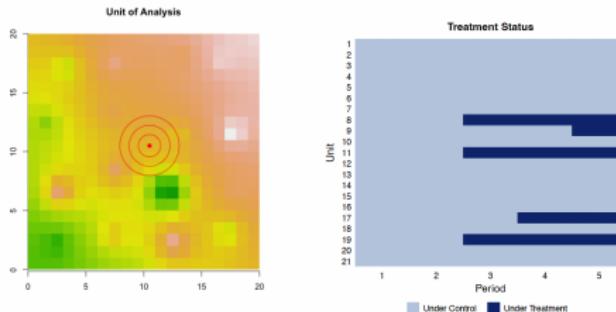


Figure 7: The plot on the left demonstrates both the treatment status of each school and interpolated outcome values from kriging in the experiment. White triangles are schools under control and black circles are treated schools. The color on the map indicates the infection rate. The plot on the right presents results using our methods. The black curve represents the AME estimate. The AME is expressed in terms of effects on the infection rate at varying distances from the schools. The black curves are 95% confidence intervals constructed from spatial HAC standard errors. The blue lines are the 2.5% and 97.5% quantiles of the effect estimates under the sharp null.

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Average Marginilized Effects (AME)



- ▶ Focus on centroids and distances between centroids.
- ▶ Treatment effect is non-monotonic function of distance.
- ▶ TE using permutations on treated nodes given distance.
- ▶ Can consider tempo-spatial spillovers. Where? When?

Next class...

Geography, climate change and (in)stability