

Estimating policy effects using spatial regression discontinuity: The case of New Jersey's minimum wage increase

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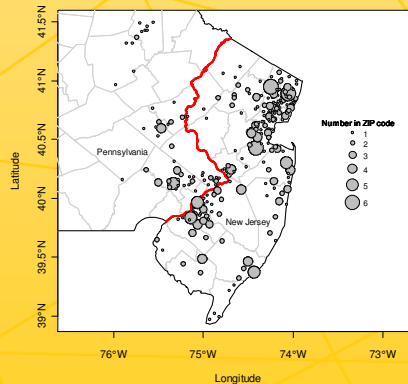
BACKGROUND

Estimating causal effects from policy-level interventions is an important aim in the field of program evaluation, but policies are typically implemented in geographically defined jurisdictions, such as school districts or states, and not by randomly assigning participants to a treatment or control group. Consistent with the Education Sciences Reform Act of 2002, the U.S. Department of Education gives preferential treatment to causal research based on "random assignment experiments or designs ... [that] eliminate plausible competing explanations." Geographic information systems (GIS) are not widely used in education research but may help isolate compelling explanations when estimating the effect of a policy on educational outcomes.

PURPOSE

Can GIS help evaluators and policy analysts comply with federal priorities for causal research in education? The purpose of this study is to apply GIS and cross-disciplinary inquiry (i.e., across education, geography, economics, and statistics) to the case of treatment assignment based on geographic borders. Geographic information from a well-known study of minimum wage effects by Card and Krueger (1994) was harnessed with GIS software. Data were then analyzed using regression discontinuity (RD). The strengths and limitations of GIS and spatial RD are discussed in the context of statistical results.

Restaurants surveyed by Card and Krueger



DATA AND METHODS

Card and Krueger surveyed fast food restaurants in Pennsylvania (PA) and New Jersey (NJ) before and after New Jersey raised its minimum wage from \$4.25 to \$5.05 in 1992. Economic theory asserts that increasing minimum wage should cause employment to decrease. However, Card and Krueger's "natural experiment" found a lack of evidence that employment decreased in New Jersey relative to Pennsylvania. Strengths of Card and Krueger's study include pretest observations, a counterfactual (i.e., Pennsylvania), and statistical controls; limitations include potential sample bias, limited generalizability beyond food service, and possible omission of important variables. Card and Krueger's findings have largely withstood criticism (Cascio et al., 2001) and have been used to argue for measured increases in minimum wage, such as the Fair Minimum Wage Act of 2007.

Variable	Before increase		After increase	
	PA	NJ	PA	NJ
Starting hourly wage	\$4.64 (\$0.35)	\$4.61 (\$0.35)	\$4.63 (\$0.36)	\$5.08 (\$0.10)
FTE employees	23.5 (12.0)	20.4 (9.1)	21.3 (8.4)	21.0 (9.2)

Card and Krueger's analysis entailed regressing change in full time equivalent (FTE) employment on a state location dummy variable (1 if NJ; 0 if PA) to estimate the effect of the minimum wage increase. Nested model comparisons indicated that sub-state regions (e.g., 1 if located in NJ shore region; 0 if not) and chain ownership control variables did not collectively explain a significant amount of variation in employment change.

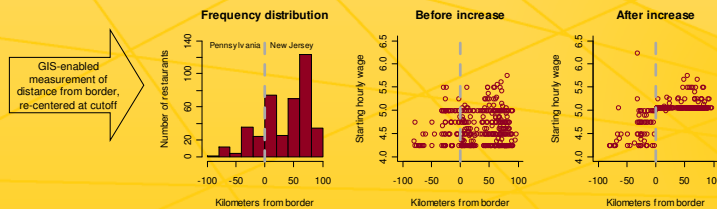
I re-analyzed Card and Krueger's data using spatial regression discontinuity. Regression discontinuity (RD) is a quasi-experimental design and analysis approach favored by the U.S. Department of Education and other federal agencies because well-designed RD studies yield causal estimates that are comparable to those derived from randomized controlled trials (RCTs; Galindo and Shadish, 2008). Moreover, the treatment assignment process is completely known and perfectly measured—a feature that RD theoretically shares with RCTs (Shadish, Cook, & Campbell, 2002). Estimating the treatment effect locally at the cutoff point is the goal of RD analysis, and correctly specifying the functional form is key to obtaining unbiased estimates. As such, my initial specification was:

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 Z_i + \beta_3 X_i Z_i + \beta_4 Z_i^2 + \beta_5 X_i Z_i^2 + \beta_6 Z_i^3 + \beta_7 X_i Z_i^3 + \epsilon_i$$

where Y_i is within-restaurant change in FTE employment ($M_{PA} = -2.31$, $SD_{PA} = 11.0$; $M_{NJ} = 0.5$, $SD_{NJ} = 8.3$), X_i is the treatment dummy variable (1 if NJ; 0 if PA), and Z_i is distance from the PA-NJ border re-centered so that 0 represents the cutoff point ($M_{PA} = -30.6$, $SD_{PA} = 21.8$; $M_{NJ} = 50.4$, $SD_{NJ} = 27.3$).

In contrast to Card and Krueger's model, mine theorizes that restaurants were assigned to the treatment condition based on their location relative to the PA-NJ border by controlling precisely for distance. One rationale underlying this theory is that a slight shift in the state border would have changed treatment assignment. Another rationale is that restaurants in close proximity to each other along the border (e.g., in the Philadelphia metropolitan area) should have more in common than restaurants separated by long distances and located in different markets (e.g., NJ restaurants near Philadelphia versus New York City). Card and Krueger applied a similar rationale by including regional control variables.

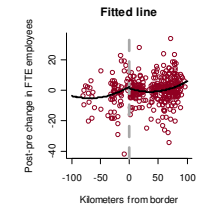
Intermediate geospatial steps were performed in R 2.8.0 and ArcGIS 9.3. R was used to join ZIP code centroid coordinates to Card and Krueger's data, create a line shapefile where the PA and NJ borders intersect, map locations, and perform statistical analyses. The ArcGIS Near tool was used to measure each restaurant's distance from the PA-NJ border.



RESULTS

The final model explains about 3 percent of total variation in the dependent variable (i.e., post-pre change in FTE employees). Of the models examined, the final is the most parsimonious with significant higher order terms. The confidence interval for the mean difference in Y at the PA-NJ border ($CI_{0.95} = -6.30, 3.64$) suggests that raising the minimum wage by 19 percent had an insignificant effect on employment in the food service industry. This finding corresponds with Card and Krueger's conclusion.

	Est.	Robust SE	t	p
Intercept	2.31	2.60	0.89	0.374
X (1 if NJ)	-1.33	2.53	-0.53	0.599
Z	0.22	0.08	2.76	0.006
$X \cdot Z$	-0.34	0.13	-2.58	0.010
Z^2	0.002	0.00	2.50	0.013
R^2 adj.			0.031	
F (df)	4.84 (4, 374)			p<0.001



CONCLUSIONS

This study presented a case in which a policy was implemented in a geographically defined jurisdiction. Geoprocessing was used to directly estimate the effect of that policy. The key finding—that raising the minimum wage did not have a significant effect on employment—corresponds with an earlier study of the same policy change. That study made fewer assumptions about the geographic assignment of the treatment condition. I conclude that:

- GIS can help educational researchers harness geographic information to evaluate programs and policies.
- Spatial RD holds promise as a quasi-experimental evaluation tool because educational and other policies are frequently implemented along geographic boundaries, rather than by randomly assigning students or citizens, which requires stringent modeling of the assignment process to minimize competing explanations.
- More methodological inquiry is needed to judge how well and under what conditions spatial RD yields unbiased estimates.

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