Principles of Empirical Analysis

Lecture 9b: Difference-in-differences with staggered treatment timing

Spring 2022
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Outline

- **Basic idea of DID when the timing of treatment varies across units**
- **Applications**
  - Currie & Reed (2011): pollution and health

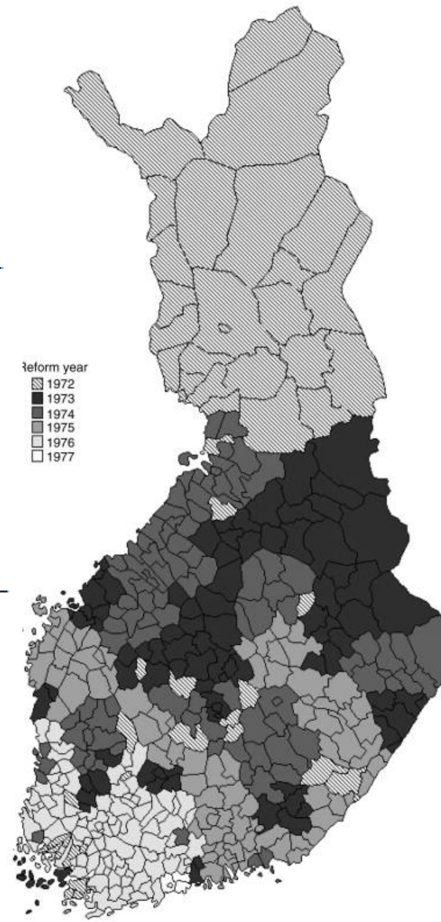
Staggered of differential treatment timing

- **The canonical difference-in-differences (DID) design contains two time periods and two groups where the timing of treatment is the same for all treated**
  - In our examples thus far, the treatment timing was the same for all units
- **Most DID applications, however, exploit variation across groups of units that receive treatment at different times**
  - In some applications, all units are eventually treated while in others there is a control group that never gets treated

Rollout implementation of a policy – Pekkarinen et al. (2009)

Abstract

This paper estimates the effect of a major education reform on intergenerational income mobility. The Finnish comprehensive school reform of 1972–1977 replaced the old two-track school system with a uniform nine-year comprehensive school and shifted the selection of students to vocational and academic tracks from age 11 to age 16. We estimate the effect of this reform on the intergenerational income elasticity using a representative sample of males born between 1960 and 1966. The identification strategy relies on a differences-in-differences approach and exploits the fact that the reform was implemented gradually across the country during a six-year period. The results indicate that the reform reduced the intergenerational income elasticity by 23% from the pre-reform elasticity of 0.30 to post-reform elasticity of 0.23.



https://www.sciencedirect.com/science/article/pii/S0047272709000619

Rollout implementation of a policy – Böckerman et al. (2019)

Abstract

We exploit a large-scale natural experiment—the rollout of a nationwide electronic prescribing system in Finland—to study how digitization of prescriptions affects pharmaceutical use and health outcomes. We use comprehensive administrative data from patients treated with benzodiazepines, which are globally popular, effective but addictive psychotropic medications. We find no impact on benzodiazepine use on average, but among younger patients e-prescribing increases repeat prescription use. Younger patients' health outcomes do not improve but adverse outcomes, such as prescription drug abuse disorders and suicide attempts, increase dramatically. Improving access to medication through easier ordering may thus increase medication overuse.

Key words: health information technology, electronic prescribing, repeat prescriptions, inefficiency, medication overuse

JEL classes: H51, H75, I12, I18

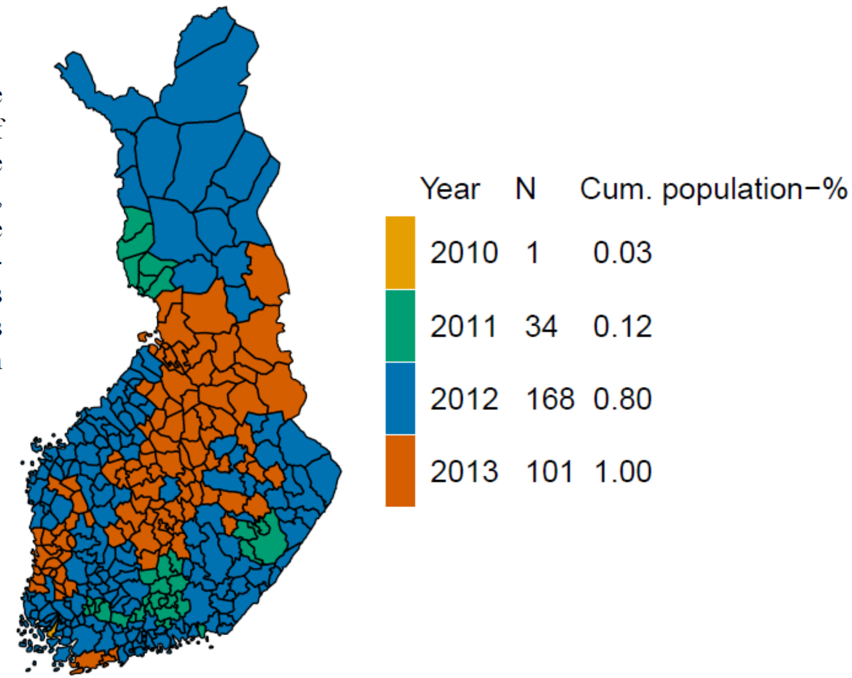
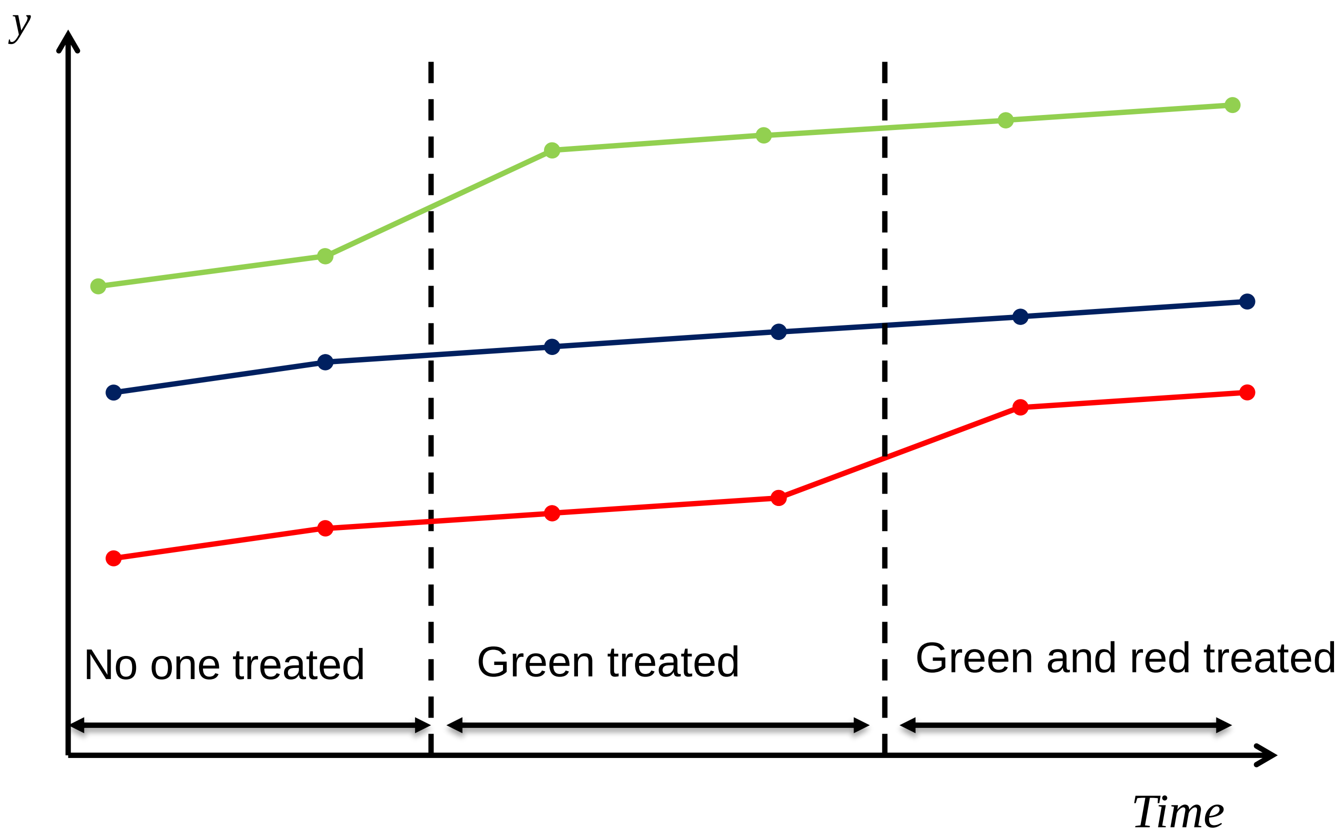


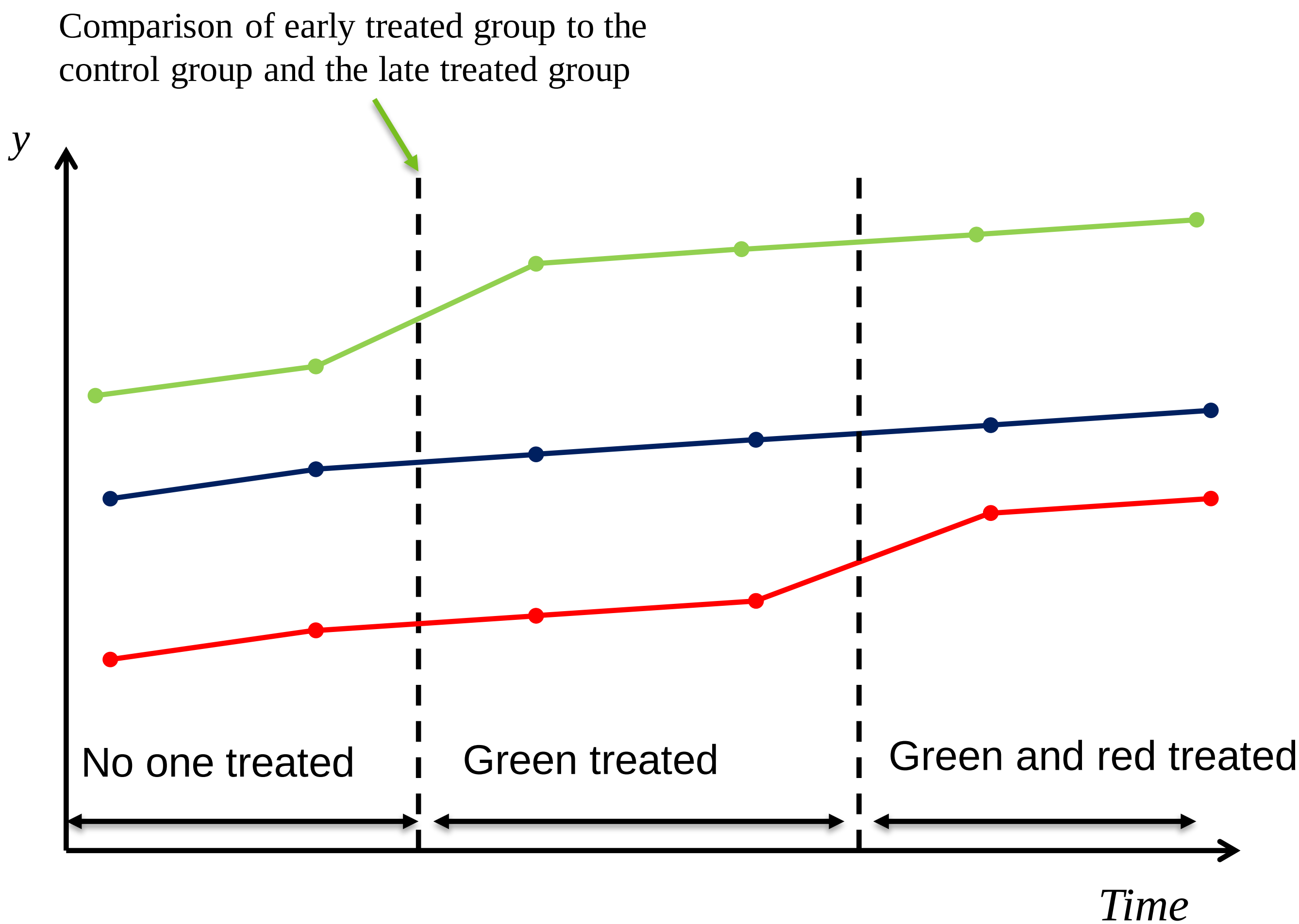
FIGURE 1: E-prescribing Adoption Year in Municipalities

https://vatt.fi/julkaisu?pubid=URN%3AISBN%3A978-952-274-235-3

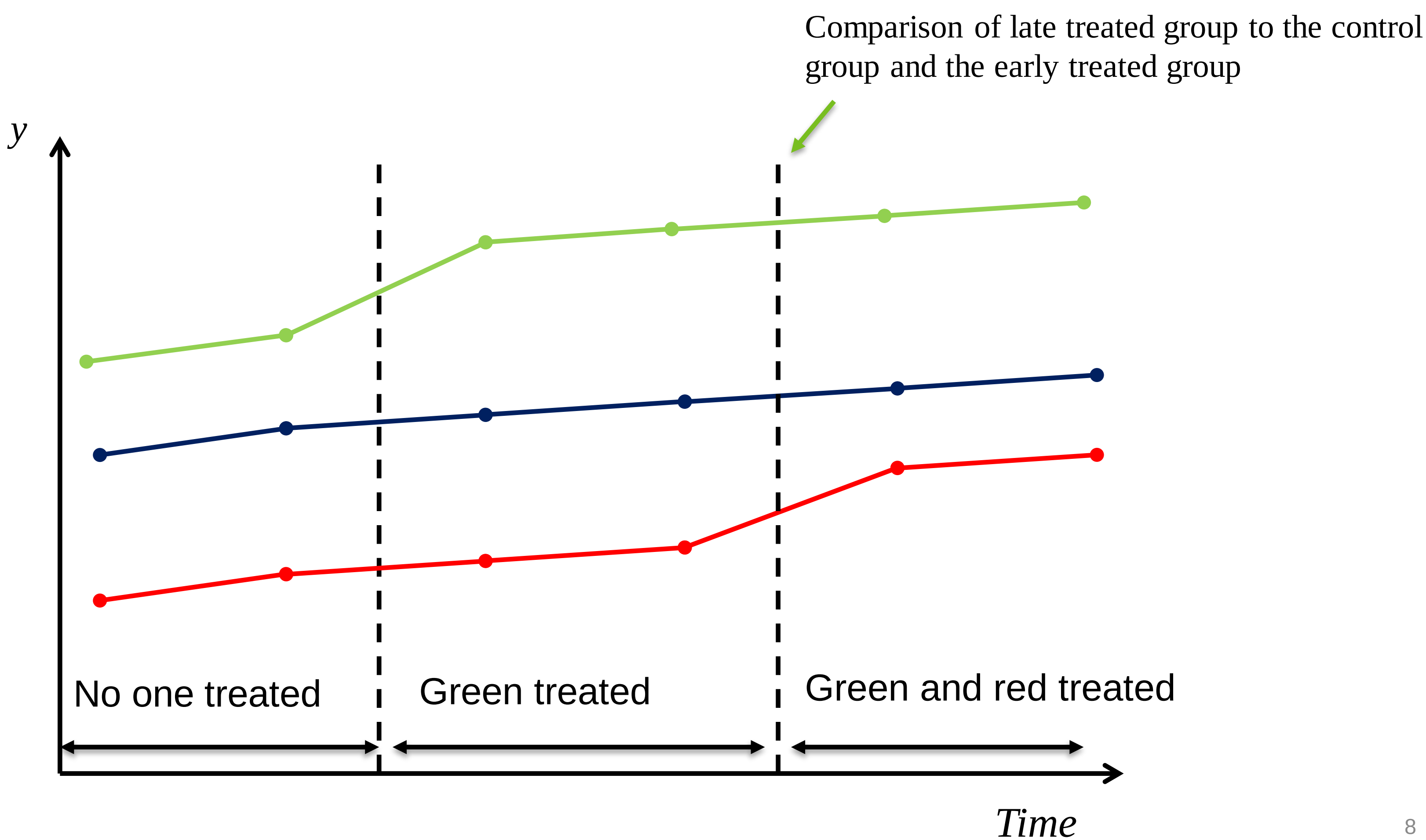
Staggered timing - example



Staggered timing - example



Staggered timing - example



American Economic Journal: Applied Economics 3 (January 2011): 65–90
http://www.aeaweb.org/articles.php?doi=10.1257/app.3.1.65

Traffic Congestion and Infant Health: Evidence from E-ZPass†

By Janet Currie and Reed Walker*

We exploit the introduction of electronic toll collection, (E-ZPass), which greatly reduced both traffic congestion and vehicle emissions near highway toll plazas. We show that the introduction of E-ZPass reduced prematurity and low birth weight among mothers within 2 kilometers (km) of a toll plaza by 10.8 percent and 11.8 percent, respectively, relative to mothers 2–10 km from a toll plaza. There were no immediate changes in the characteristics of mothers or in housing prices near toll plazas that could explain these changes. The results are robust to many changes in specification and suggest that traffic congestion contributes significantly to poor health among infants. (*JEL* I12, J13, Q51, Q53, R41)

https://www.aeaweb.org/articles?id=10.1257/app.3.1.65

Motivation

- **Motor vehicles are a major source of air pollution**
  - Nationally they are responsible for over 50 percent of carbon monoxide (CO), 34 percent of nitrogen dioxide (NO2), and over 29 percent of hydrocarbon emissions, in addition to as much as 10 percent of fine particulate matter emissions
- **In urban areas, vehicles are the dominant source of these emissions**

Research question

- **Studies the effect of E-ZPass, and thus the sharp reductions in local traffic congestion, on the health of infants born to mothers living near toll plazas**
- **This is interesting for three reasons:**

1. There is increasing evidence of the long-term effects of poor health at birth on future outcomes
2. The study of newborns overcomes several difficulties in making the connection between pollution and health because the link between cause and effect is immediate
3. E-ZPass is an interesting policy experiment because, while pollution control was an important consideration for policy makers, the main motive for consumers to sign up for E-ZPass is to reduce travel time

Selection bias

- **Since air pollution is not randomly assigned, studies comparing health outcomes for populations exposed to differing pollution levels may not adequately control for confounding determinants of health**
  - Families with higher incomes or preferences for cleaner air are likely to sort into locations with better air quality, and failure to account for this sorting overestimates of the effects of pollution
  - Alternatively, pollution levels are higher in urban areas where there are often more educated individuals with better access to health care, which can cause underestimates of the true effects of pollution on health

Empirical strategy

- **In the absence of a randomized trial, we**
  - exploit a policy change that created large local and persistent reductions in traffic congestion and traffic related air emissions for certain segments along a highway
  - compare the infant health outcomes of those living near an electronic toll plaza before and after implementation of E-ZPass to those living near a major highway but further away from a toll plaza

Empirical strategy

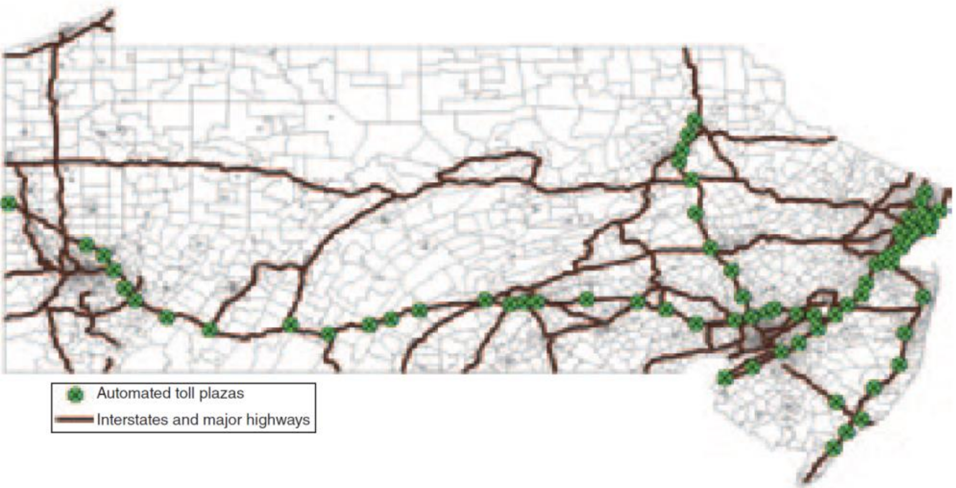


Figure 1. Locations of Toll Plazas and Major Roadways in New Jersey and Pennsylvania

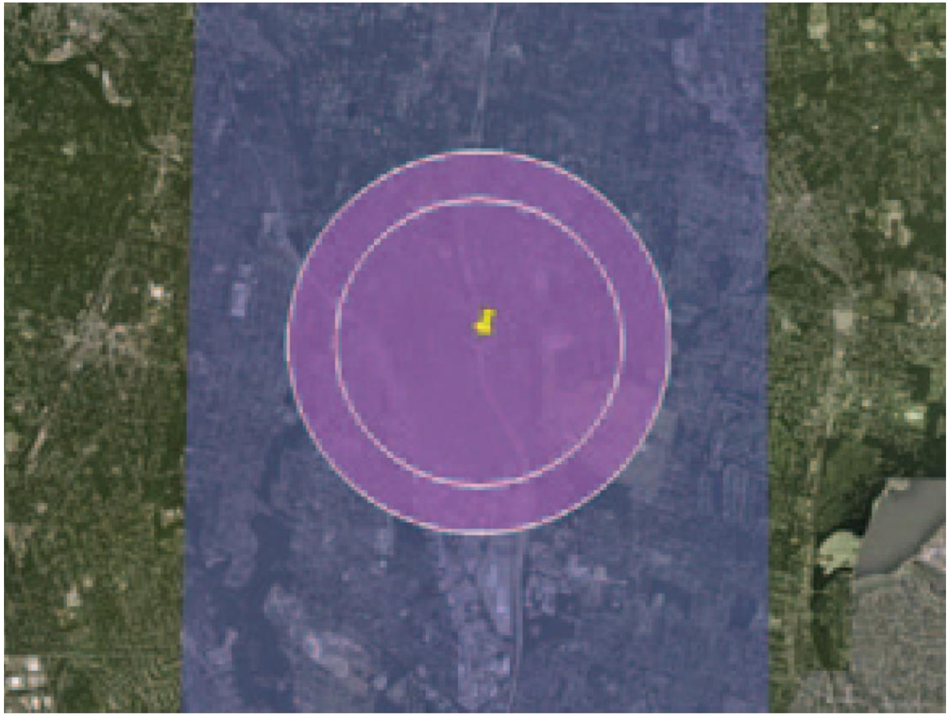


Figure 2. Research Design Showing 1.5 km and 2 km Treatment Radii and 3 km from Highway Control Group

Empirical strategy

- **“Specifically, we compare mothers within 2 km of a toll plaza to mothers who are between 2 km and 10 km from a toll plaza, but still within 3 km, of a major highway before and after the adoption of E-ZPass in New Jersey and Pennsylvania.”**
- **Assumption:**
  - “Our difference in differences research design relies on the assumption that the characteristics of mothers near a toll plaza change over time in a way that is comparable to those of other mothers who live further away from a plaza, but still close to a major highway.”

Results – desc stat and crude DID

Table 1—Summary Statistics

	<2 km E-ZPass before	<2 km E-ZPass after	>2 km and <10 km E-ZPass before	>2 km and <10 km E-ZPass after	>10 km Toll plaza
Panel A. Difference-in-difference sample					
Outcomes					
Premature	0.095	0.095	0.102	0.109	0.085
Low birth weight	0.082	0.078	0.089	0.092	0.078
Controls					
Mother Hispanic	0.291	0.332	0.165	0.229	0.054
Mother black	0.16	0.173	0.233	0.264	0.047
Mother education	13.12	13.2	13.276	13.24	12.92
Mother HS dropout	0.169	0.164	0.154	0.163	0.173
Mother smoked	0.089	0.075	0.109	0.086	0.152
Teen mother	0.073	0.061	0.082	0.069	0.079
Birth order	1.3	1.37	1.39	1.46	1.68
Multiple birth	0.028	0.033	0.032	0.037	0.033
Child male	0.51	0.512	0.514	0.512	0.512
Distance to roadway	1.099	1.074	1.507	1.482	21
Observations	33,758	29,677	190,904	161,145	185,795
NJ observations	26,415	26,563	128,547	133,560	70,484
PA observations	7,343	3,114	62,357	27,585	115,311

Main results

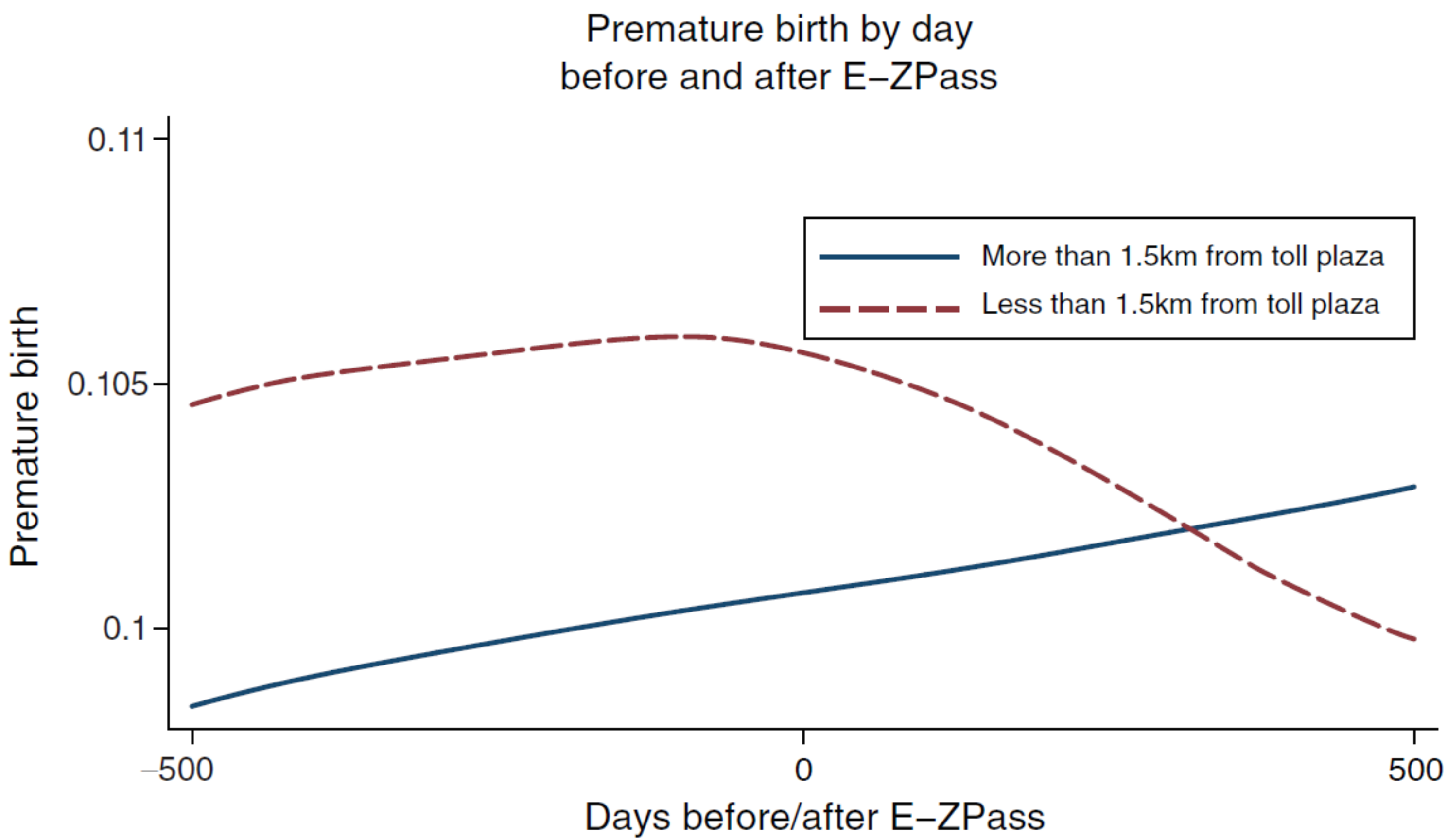


FIGURE 6

Main results

Counterfactual trend in the treatment groups

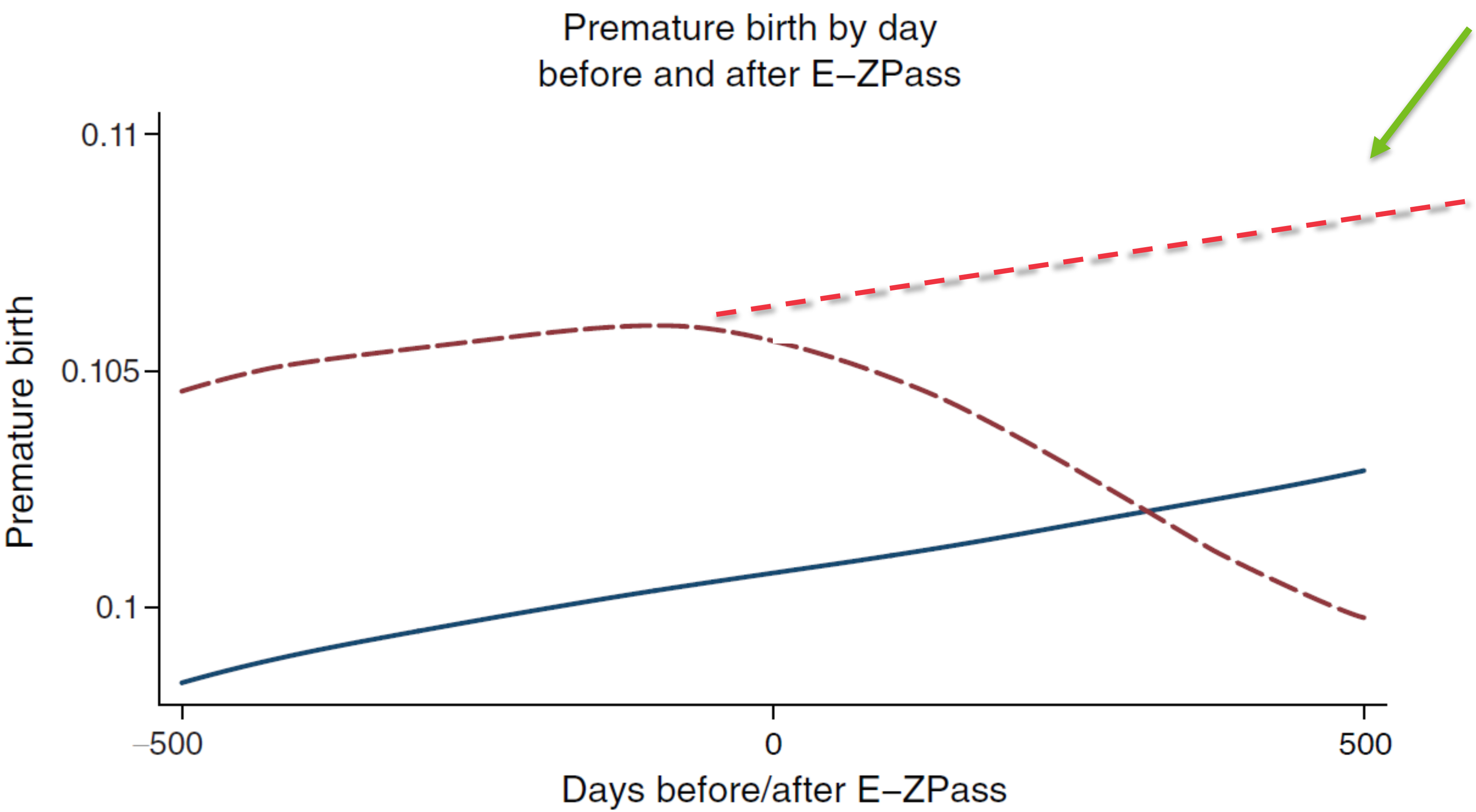


FIGURE 6

Main results

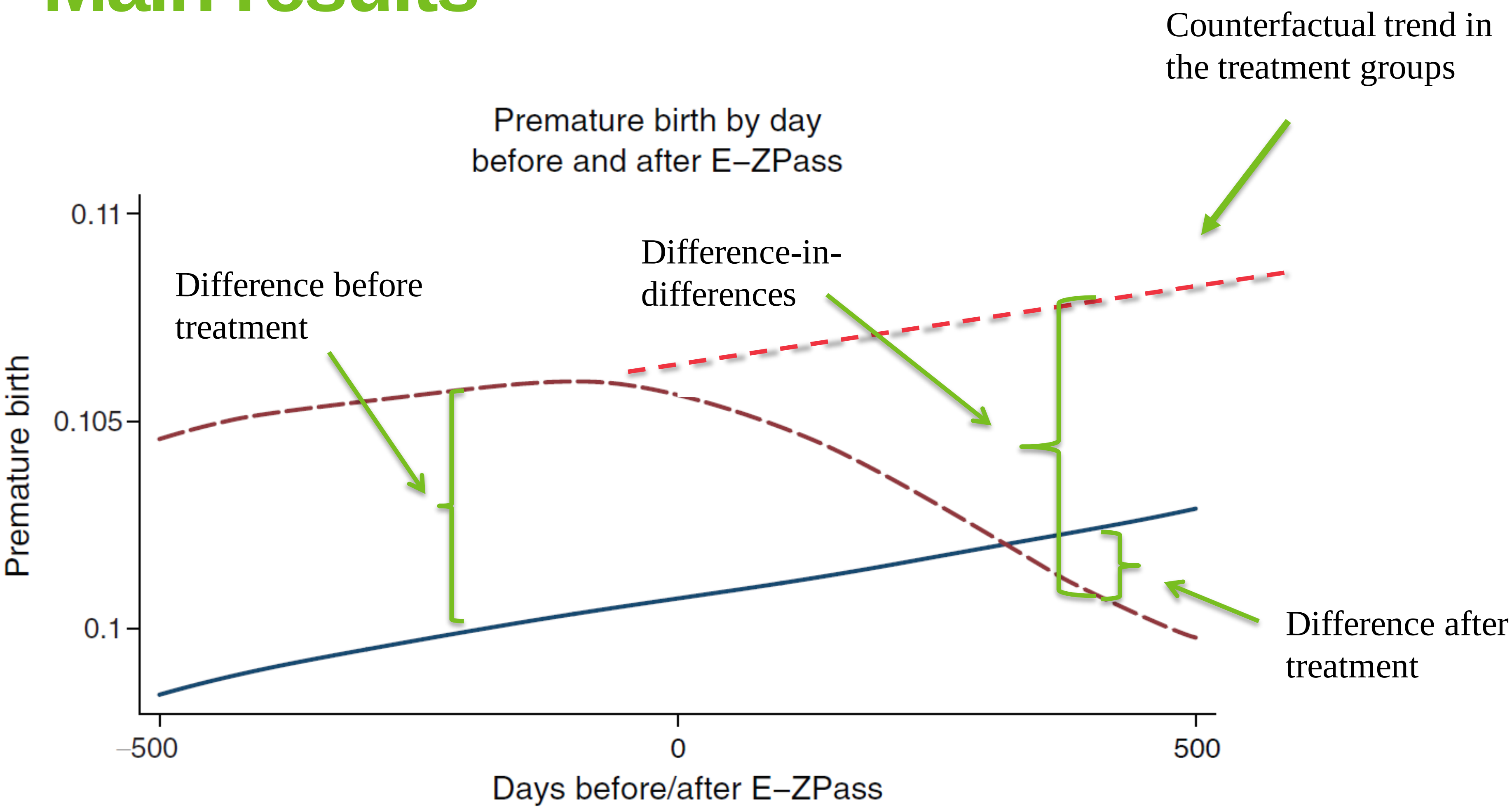


FIGURE 6

Main results

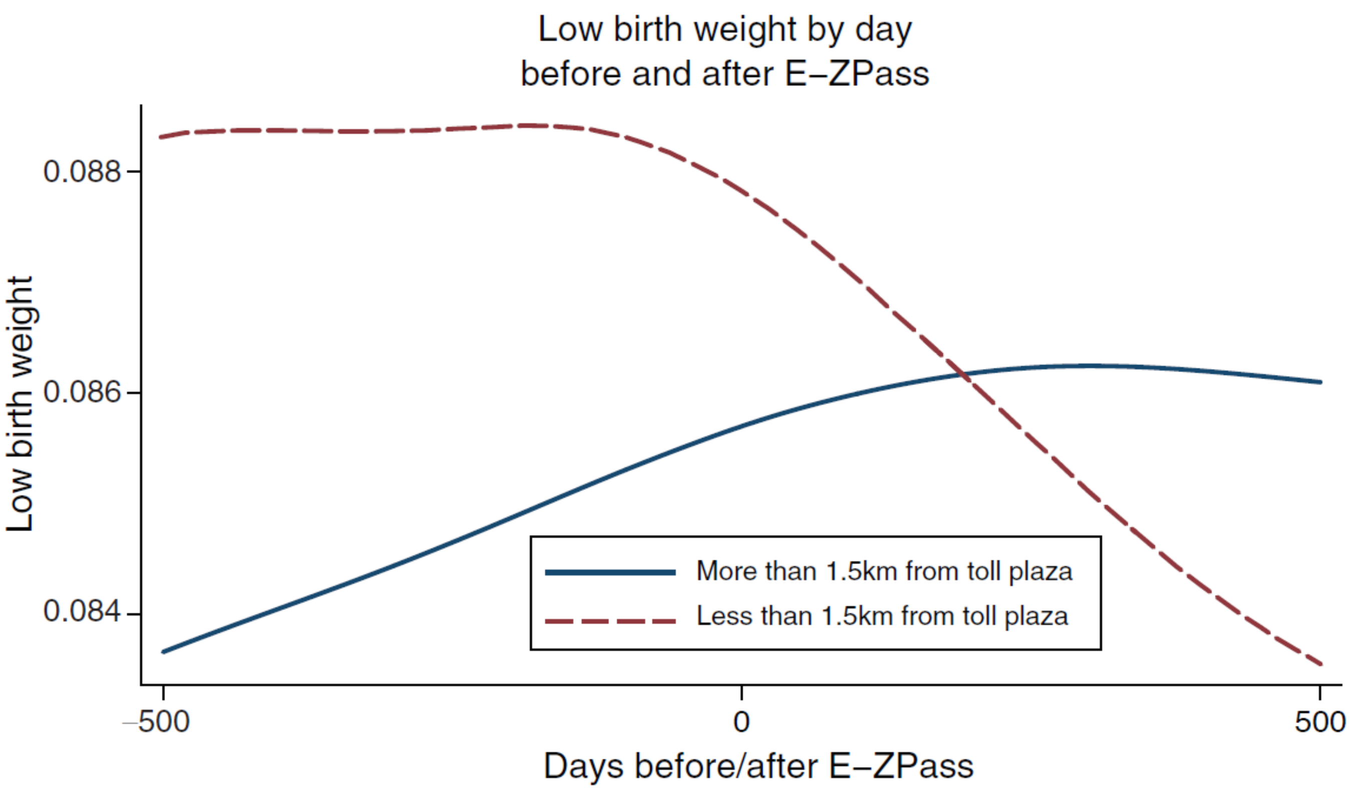


FIGURE 5

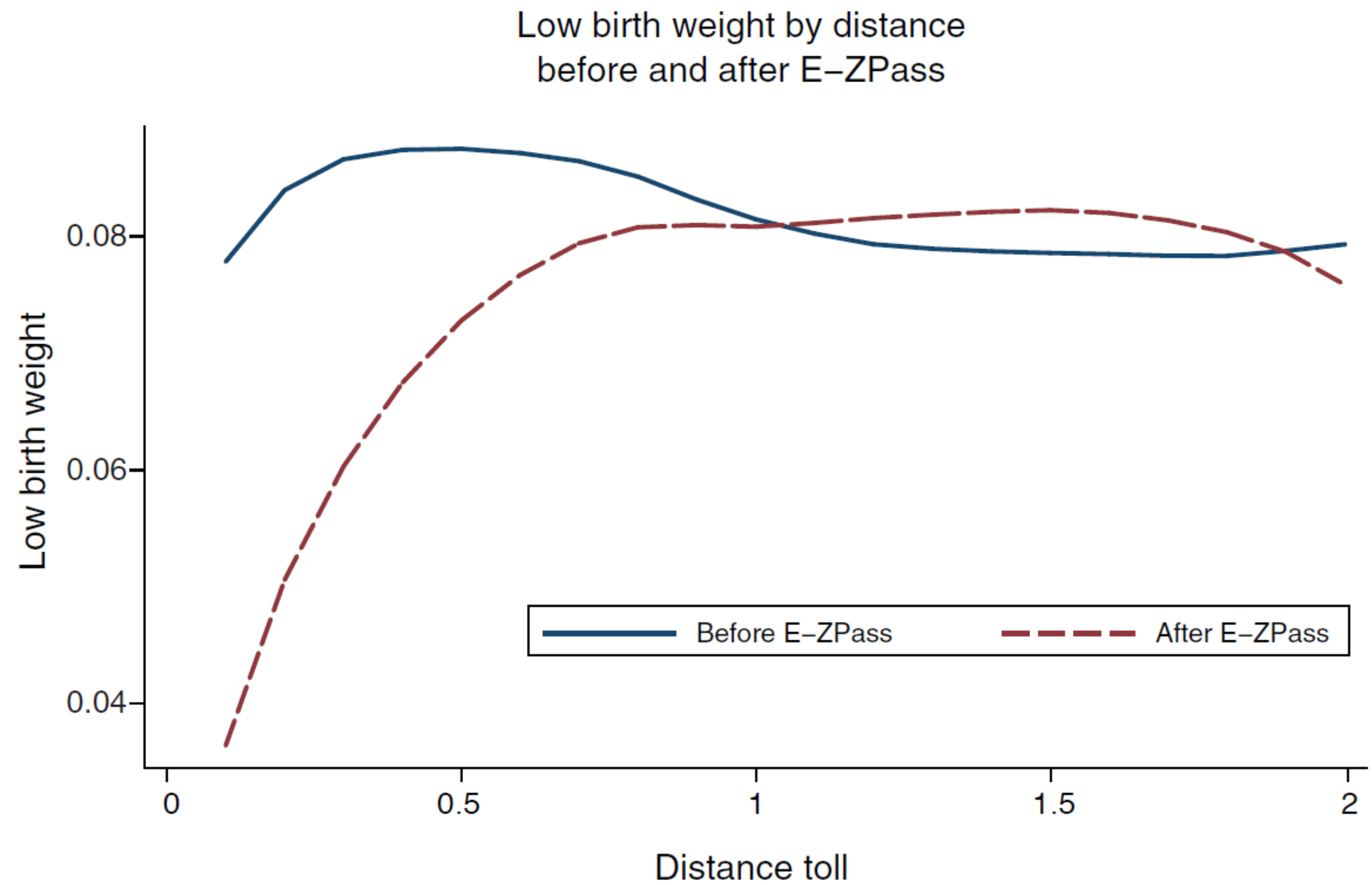


FIGURE 3

Notes: Smoothed plots of treatment and control groups using locally weighted regression. To facilitate computation, observations are first grouped into 0.1-mile bins by treatment and control and averaged. The weights are applied using a tricube weighting function (William S. Cleveland 1979) with a bandwidth of 1.

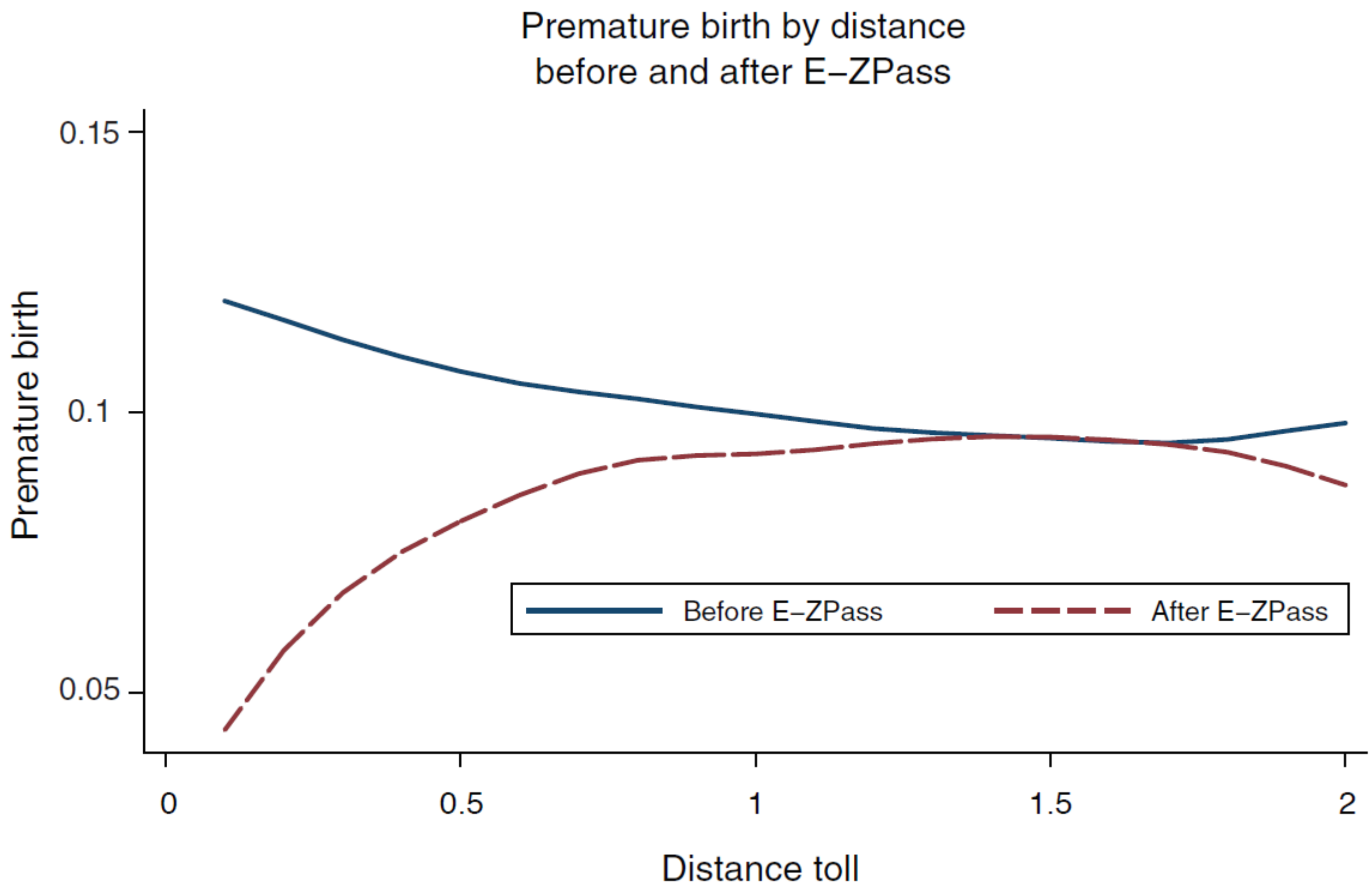


FIGURE 4

Notes: Smoothed plots of treatment and control groups using locally weighted regression. To facilitate computation, observations are first grouped into 0.1-mile bins by treatment and control and averaged. The weights are applied using a tricube weighting function (Cleveland 1979) with a bandwidth of 1.

Conclusions – Currie & Reed (2011)

- **Show that E-ZPass reduced the incidence of prematurity and low birth weight in the vicinity of toll plazas by 6.7–9.1 percent and 8.5–11.3 percent, respectively**
  - These are large but not implausible effects given the correlations between proximity to traffic and birth outcomes found in previous studies
- **Results suggest that policies intended to curb traffic congestion can have significant health benefits for local populations in addition to the more often cited benefits in terms of reducing travel costs**

Recap

- **Most DID applications exploit variation across groups of units that receive treatment at different times**
  - In some applications, all units are eventually treated, e.g. a rollout of a national policy
  - In others there is a control group that never gets treated
  - Rollout is a great way to make sure we learn something about the effects of the policy
- **In principle this is all fine**
  - But there are complicated issues concerning staggered designs and the literature is moving forward on this