FLS 6441 - Methods III: Explanation and Causation

Week 8 - Difference-in-Differences

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Classification of Research Designs

		Independence of Treatment Assignment	**Researcher Controls Treatment Assignment?**
Controlled Experiments	Field Experiments	✓	✓
	Survey and Lab Experiments	✓	✓
Natural Experiments	Natural Experiments	✓	
	Instrumental Variables	✓	
	Discontinuities	✓	
Observational Studies	Difference-in-Differences		
	Controlling for Confounding		
	Matching		
	Comparative Cases and Process Tracing		

Section 1

Difference-in-Differences

Difference-in-Differences

- What if we have *NO* variation in treatment that is independent of potential outcomes?

Difference-in-Differences

- What if we have *NO* variation in treatment that is independent of potential outcomes?
- Then we have an *Observational* study

Difference-in-Differences

- Two types of observational studies:

Difference-in-Differences

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Difference-in-Differences

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Difference-in-Differences

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2. **Time-series:** Compare units **before** and **after** treatment

Difference-in-Differences

- Two types of observational studies:

1. **Cross-sectional:** Compare across different units, **treated** and **control**
   - BUT Omitted variable bias
2. **Time-series:** Compare units **before** and **after** treatment
   - BUT Outcomes might change over time for reasons other than treatment ('Overall Trend Bias')

Difference-in-Differences

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   - Even *unobserved* characteristics

Difference-in-Differences

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Difference-in-Differences

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- Comparing **across units** and **across time**

Difference-in-Differences

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- Comparing **across units** and **across time**
- Removing the risks from both overall trends and omitted variables

Difference-in-Differences

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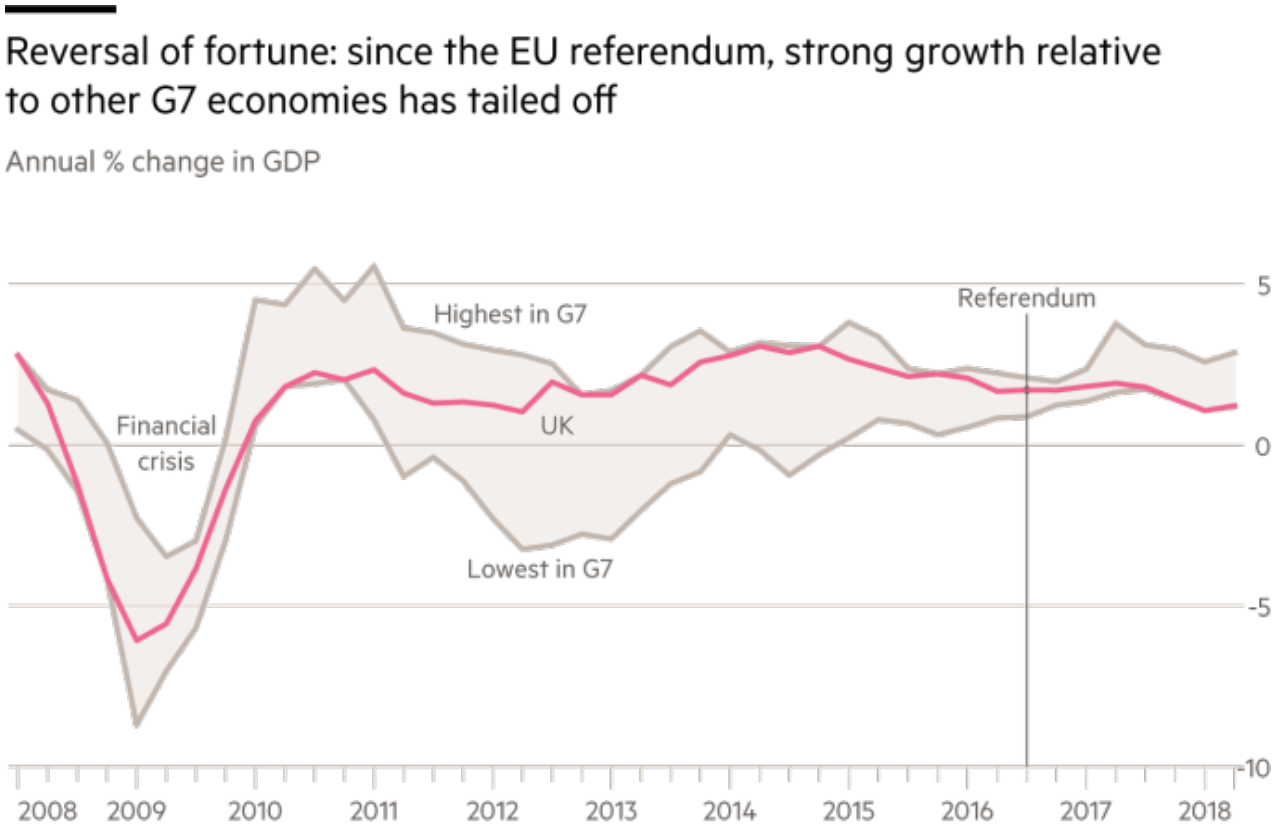
Difference-in-Differences



Difference-in-Differences

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Difference-in-Differences

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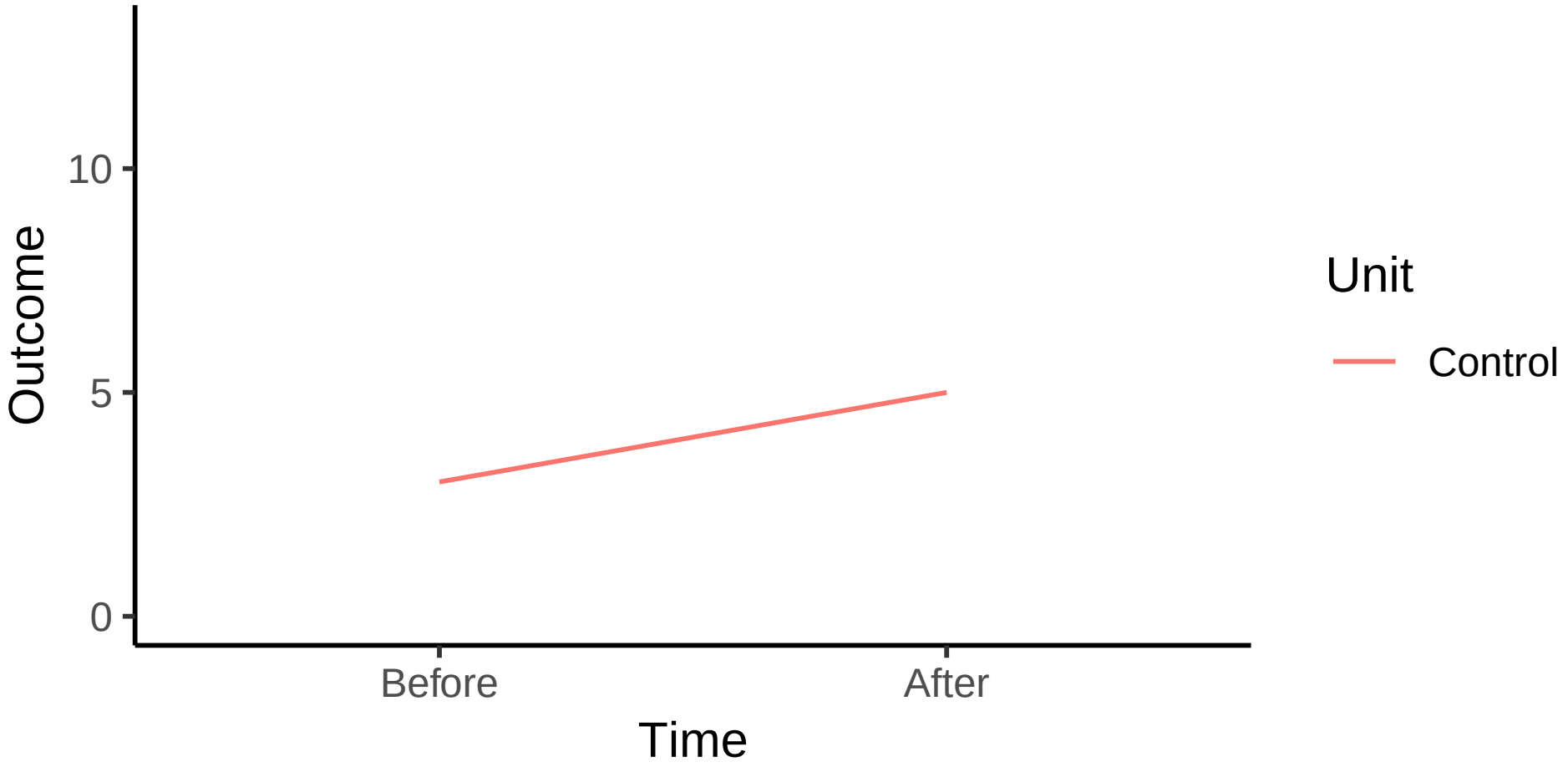
   - Diff-in-Diff does NOT control for **time-varying confounders**
   - We have to check for **Parallel pre-treatment trends**
2. Maybe the UK passed other policies at the same time as Brexit?
   - We have to check there are no **compound treatments**

Difference-in-Differences

Add caption

	Balances time-invariant 'fixed' unit characteristics		Balances time-varyi	
	Observed	Unobserved	Overall trends	Un
Field Experiments	✓	✓	✓	
Survey and Lab Experiments	✓	✓	✓	
Natural Experiments	✓	✓	✓	
Instrumental Variables	✓	✓	✓	
Regression Discontinuity	✓	✓	✓	
Cross-sectional comparisons	X	X	✓	
Before-After comparisons	✓	✓	X	
Difference-in-Differences	✓	✓	✓	

Difference-in-Differences



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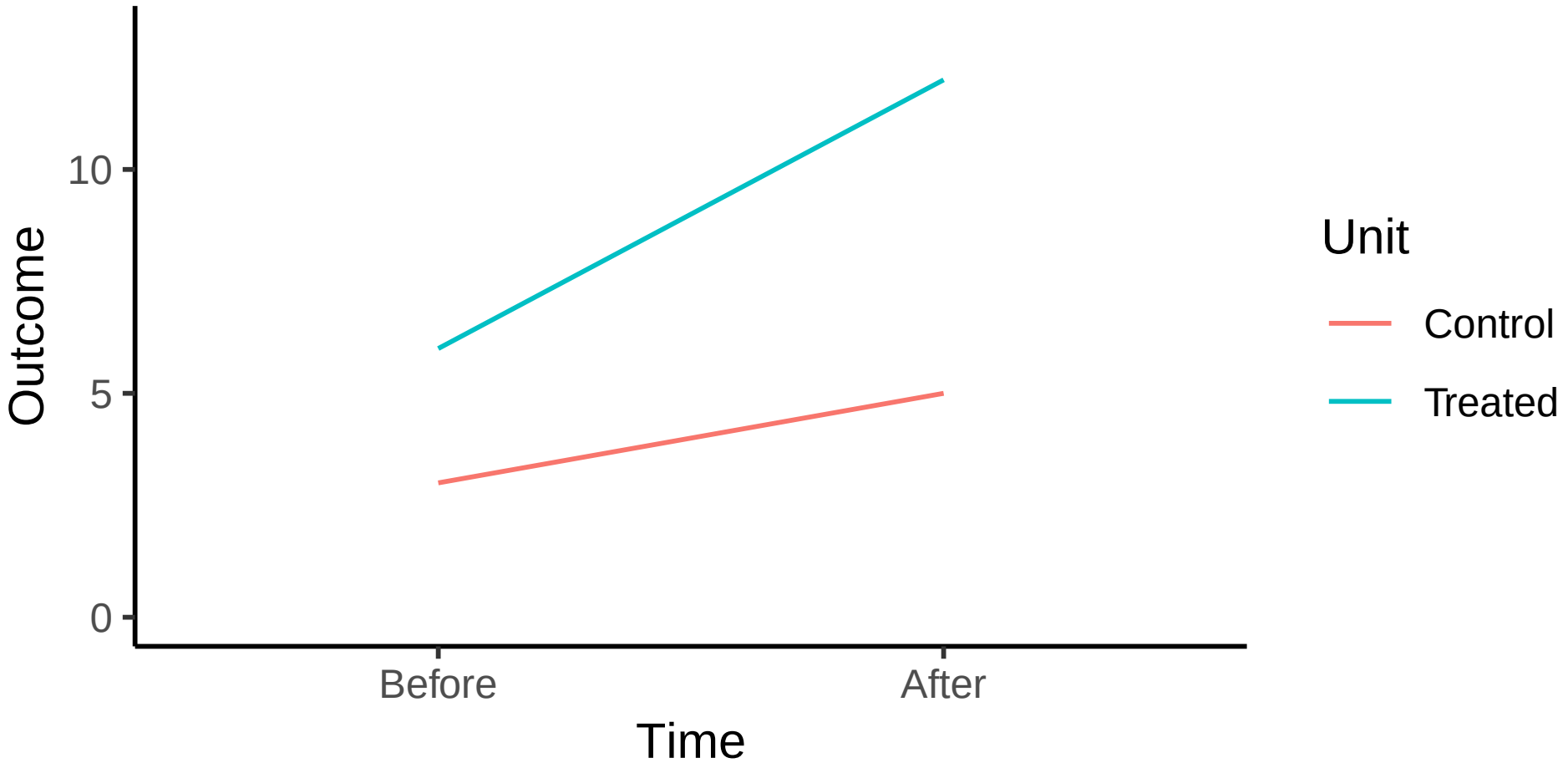

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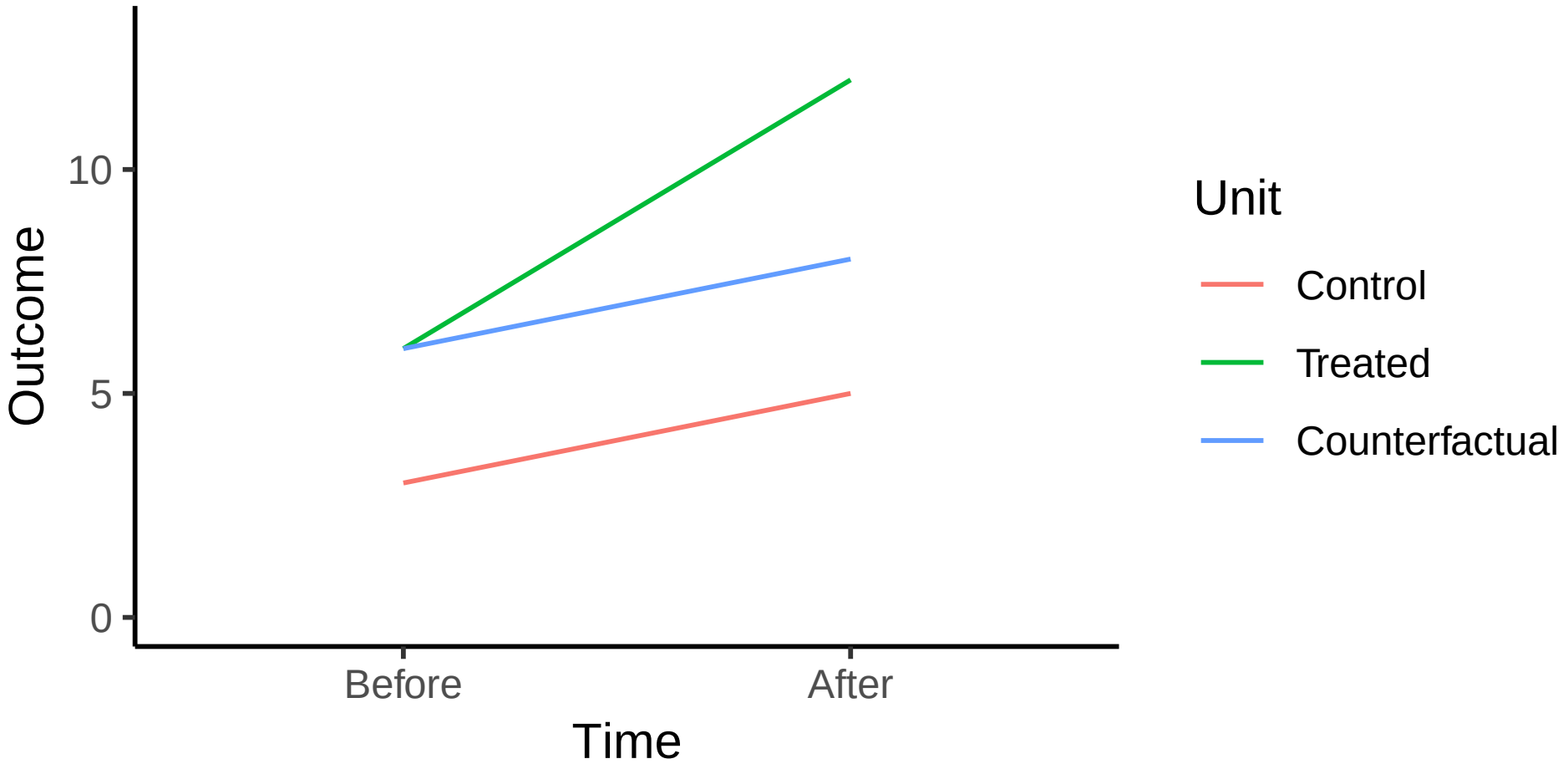

Estimating Difference-in-Differences

- Regression for the cross-unit effect of treatment

$$Y_{it} = \alpha + \gamma D_i$$

Estimating Difference-in-Differences

- Regression for the cross-unit effect of treatment

$$Y_{it} = \alpha + \gamma D_i$$

- Regression for the before-after treatment comparison

$$Y_{it} = \alpha + \gamma T_i$$

pause

- The difference-in-differences estimate is just the *interaction* of time and treatment status

$$Y_{it} = \alpha + \gamma D_i + \delta T_t + \beta D_i * T_t$$

- β is our **Average Treatment Effect** estimate

Estimating Difference-in-Differences

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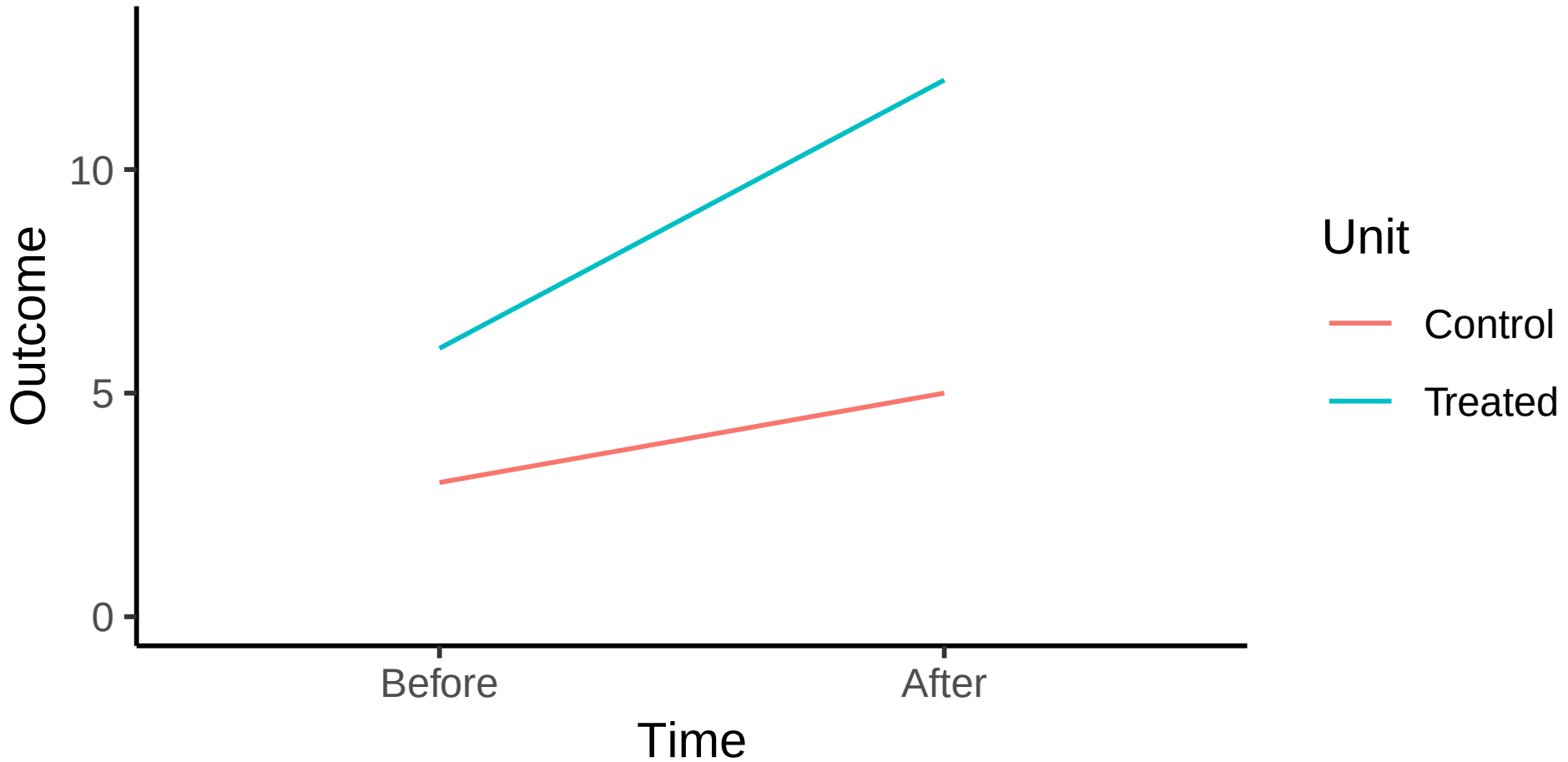
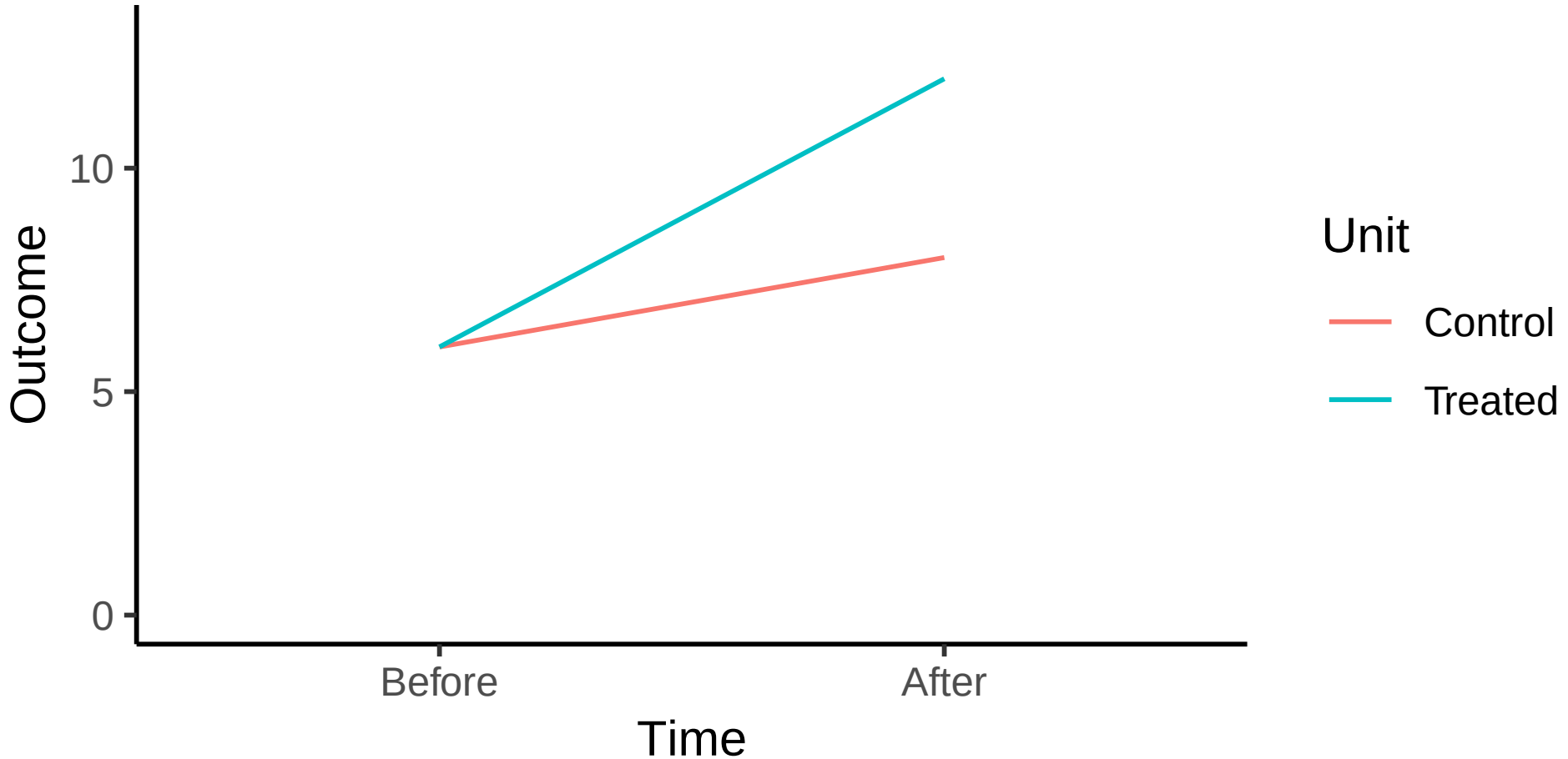
Difference-in-Differences

Raw Data:



Difference-in-Differences

Add a variable (fixed effect) for treated/control:



Difference-in-Differences

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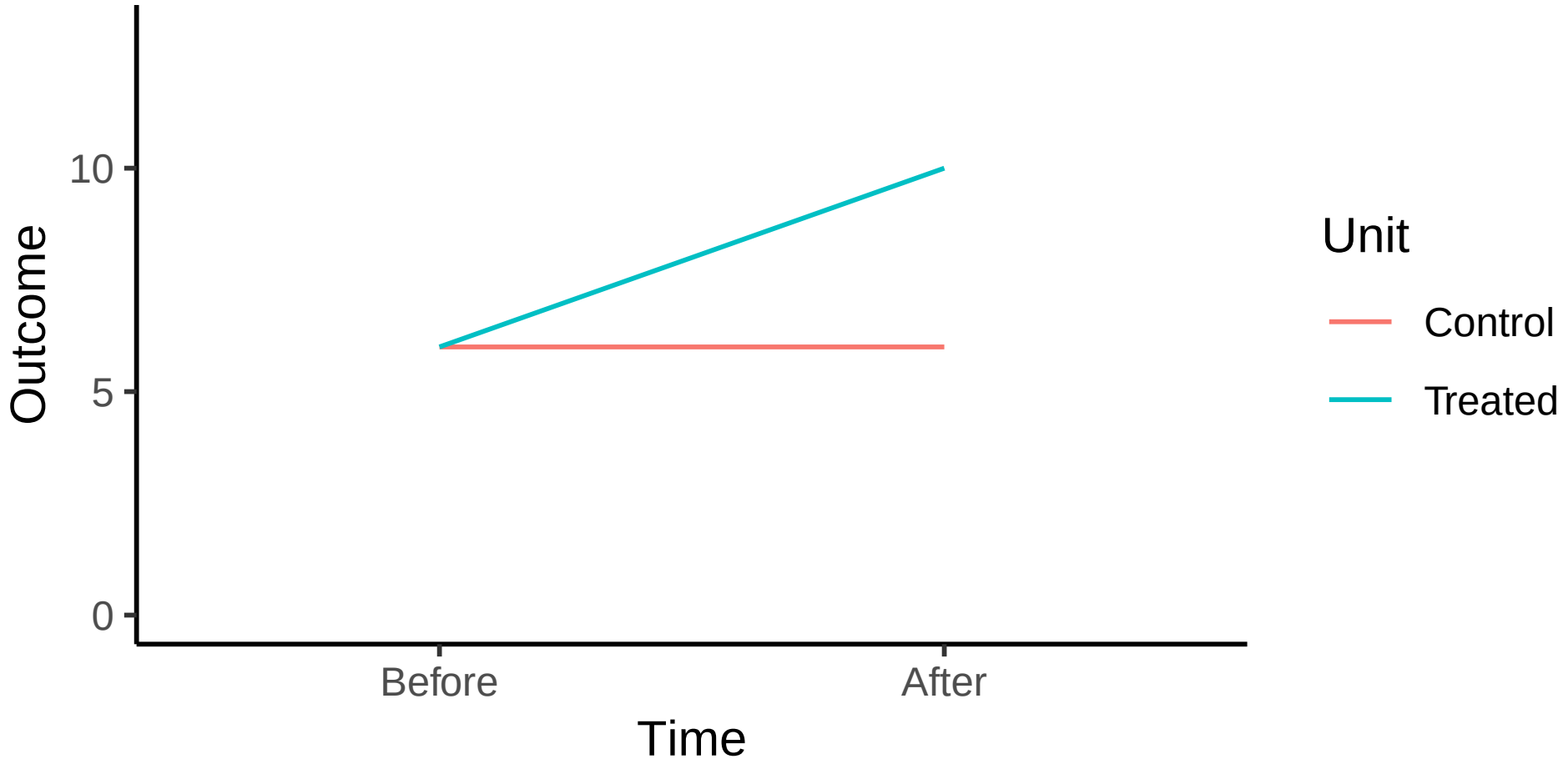

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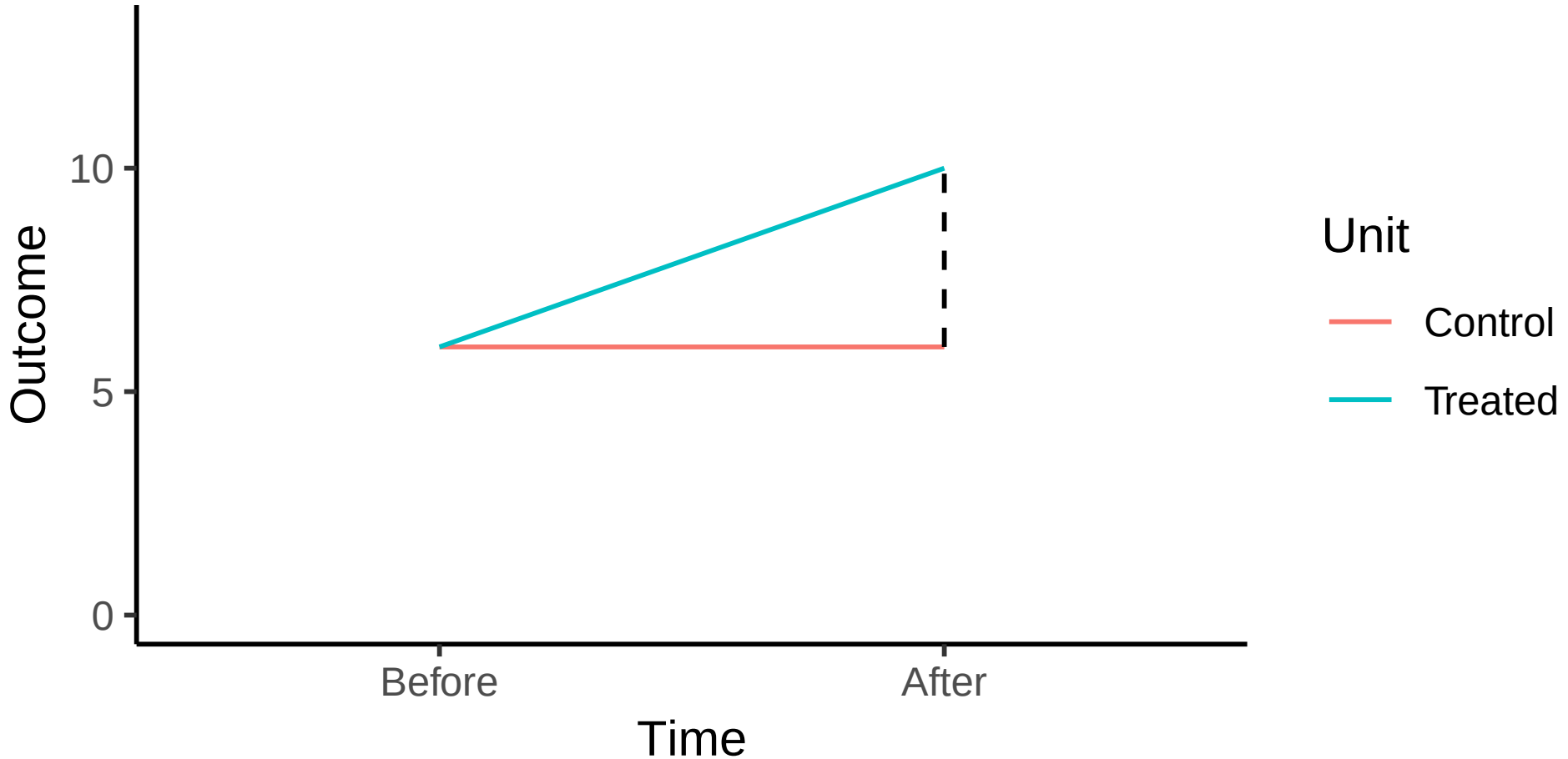

Estimating Difference-in-Differences

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Estimating Difference-in-Differences

- With time-series data, we haves temporal autocorrelation
- So crucial to cluster standard errors by each cross-sectional unit (eg. each country)

Difference-in-Differences

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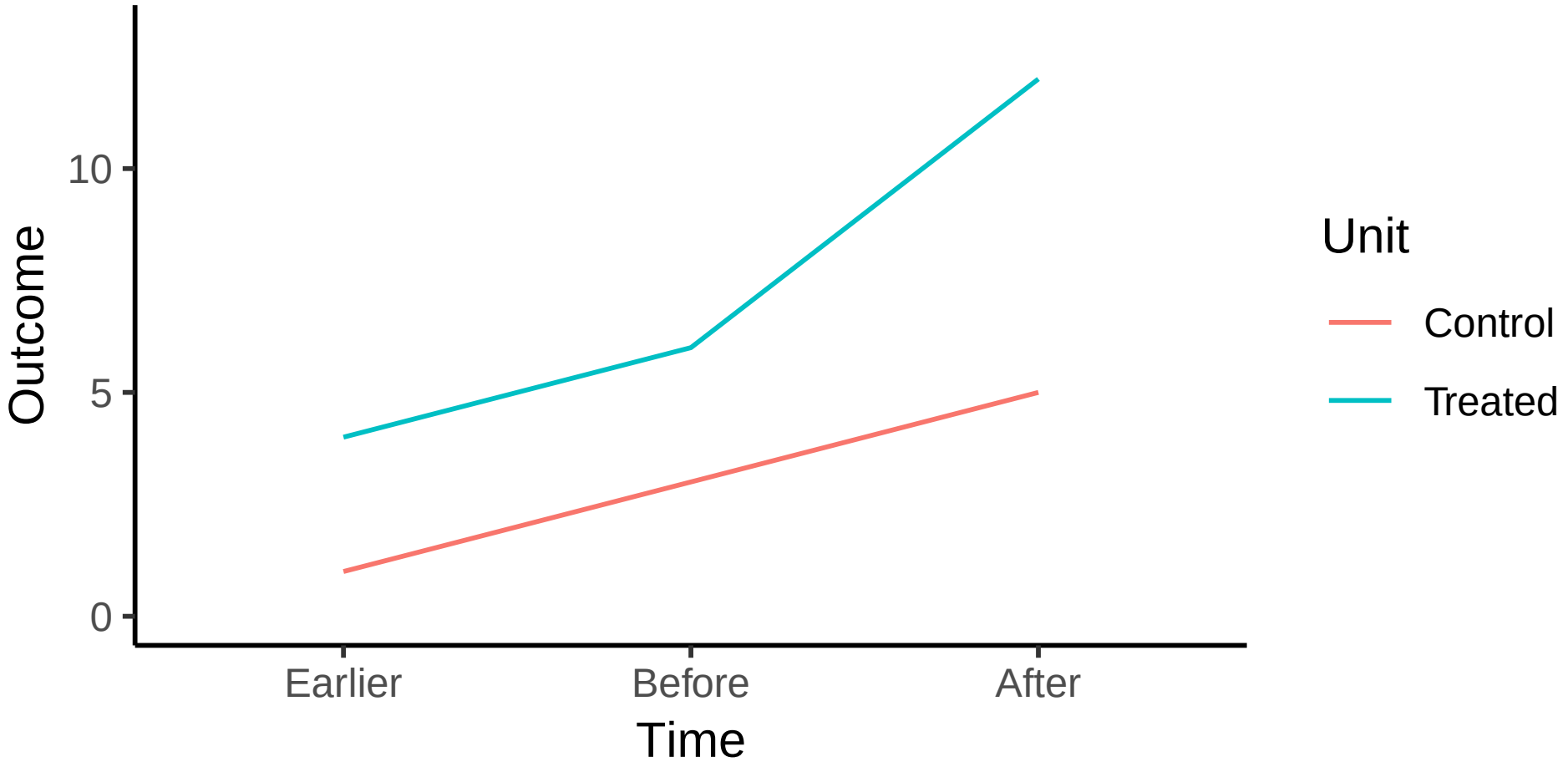
- One test of this is to check if **pre-treatment trends are parallel**

Difference-in-Differences



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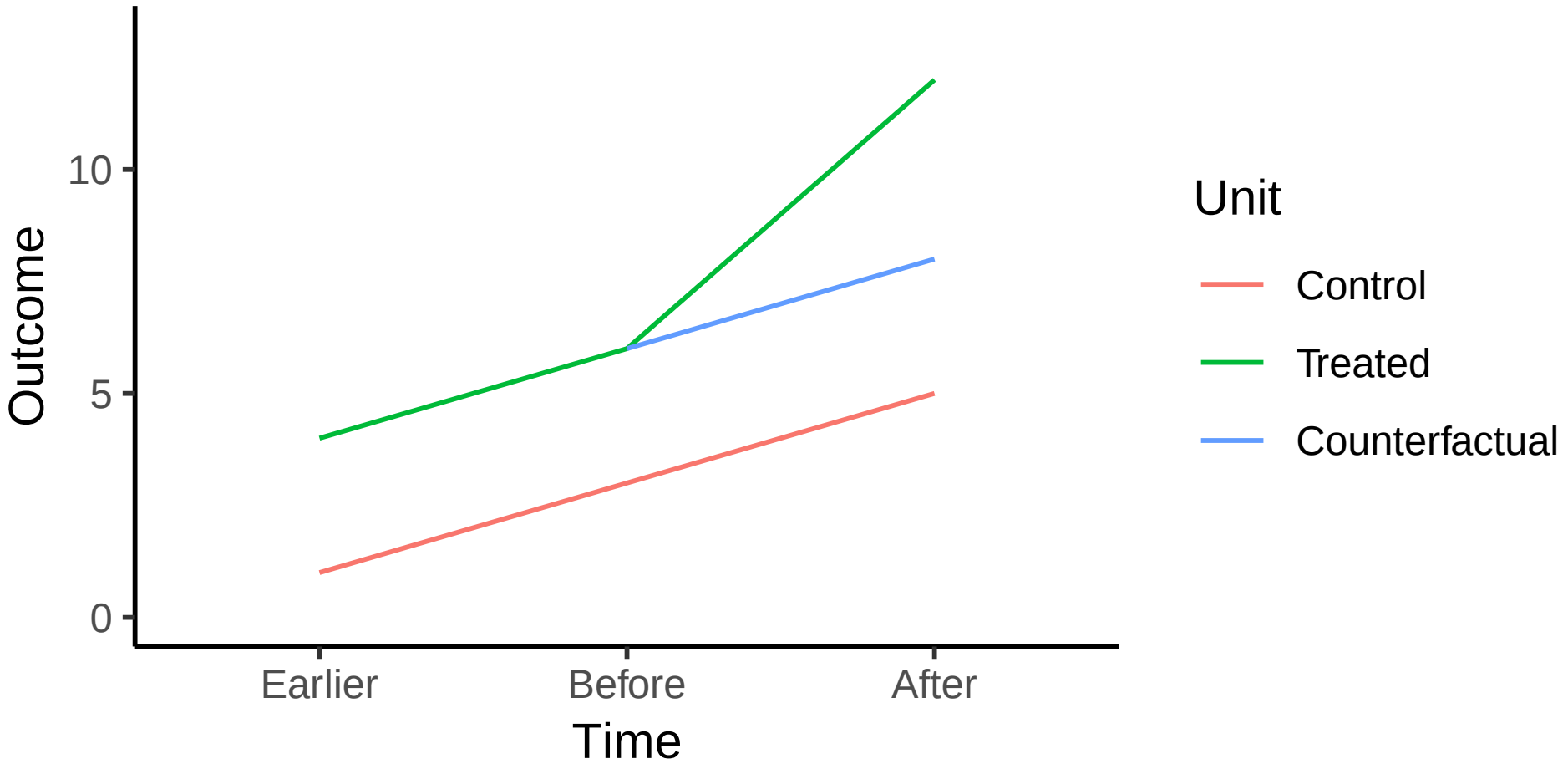

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2. No compound treatment
3. No spillovers (SUTVA)
4. Group membership is stable (no migration from control to treatment)

Section 2

Chimeli and Soares 2017

Chimeli and Soares 2017

- How does an activity being illegal affect violence?

Chimeli and Soares 2017

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- How did Brazil's ban on mahogany affect homicides?

Chimeli and Soares 2017

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Chimeli and Soares 2017

- How does an activity being illegal affect violence?
- How did Brazil's ban on mahogany affect homicides?
- What are the challenges to explanation?
  - Omitted variables, eg. State capacity
  - Overall trends, eg. national decrease in homicides
- Comparing the *change* in violence in mahogany-growing areas to the change in violence in non-growing areas

Chimeli and Soares 2017

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Chimeli and Soares 2017

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- **Control:**

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- **Control:** Municipalities **without** mahogany
- **Before:**

Chimeli and Soares 2017

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- **Control:** Municipalities **without** mahogany
- **Before:** Pre-1998

Chimeli and Soares 2017

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- So what are treatment and control here?
- **Treatment:** Municipalities with mahogany
- **Control:** Municipalities **without** mahogany
- **Before:** Pre-1998
- **After:**

Chimeli and Soares 2017

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- But the ban on mahogany applied to **all** of Brazil.
- So what are treatment and control here?
- **Treatment:** Municipalities with mahogany
- **Control:** Municipalities **without** mahogany
- **Before:** Pre-1998
- **After:** Post-1998

Chimeli and Soares 2017

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- But the ban on mahogany applied to **all** of Brazil.
- So what are treatment and control here?
- **Treatment:** Municipalities with mahogany
- **Control:** Municipalities **without** mahogany
- **Before:** Pre-1998
- **After:** Post-1998
- **Outcome:**

Chimeli and Soares 2017

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- But the ban on mahogany applied to **all** of Brazil.
- So what are treatment and control here?
- **Treatment:** Municipalities with mahogany
- **Control:** Municipalities **without** mahogany
- **Before:** Pre-1998
- **After:** Post-1998
- **Outcome:** Rate of Homicides

Chimeli and Soares 2017

- Multiple treatment timings:
  - 1st policy change
  - 2nd policy change
  - Reverse treatment: Better policing of mahogany regulations

Chimeli and Soares 2017

- Methodology:

Chimeli and Soares 2017

- Methodology:

$$Homicides_{it} = \gamma_t + \delta_i + \beta(Post-1998_t * Mahogany_i) + \epsilon_i$$

Chimeli and Soares 2017

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- Cluster standard errors by municipality

Chimeli and Soares 2017

- Methodology:

$$Homicides_{it} = \gamma_t + \delta_i + \beta(Post-1998_t * Mahogany_i) + \epsilon_i$$

- Cluster standard errors by municipality
- Apply more complex state-specific trends for covariates to minimize risk of non-parallel trends

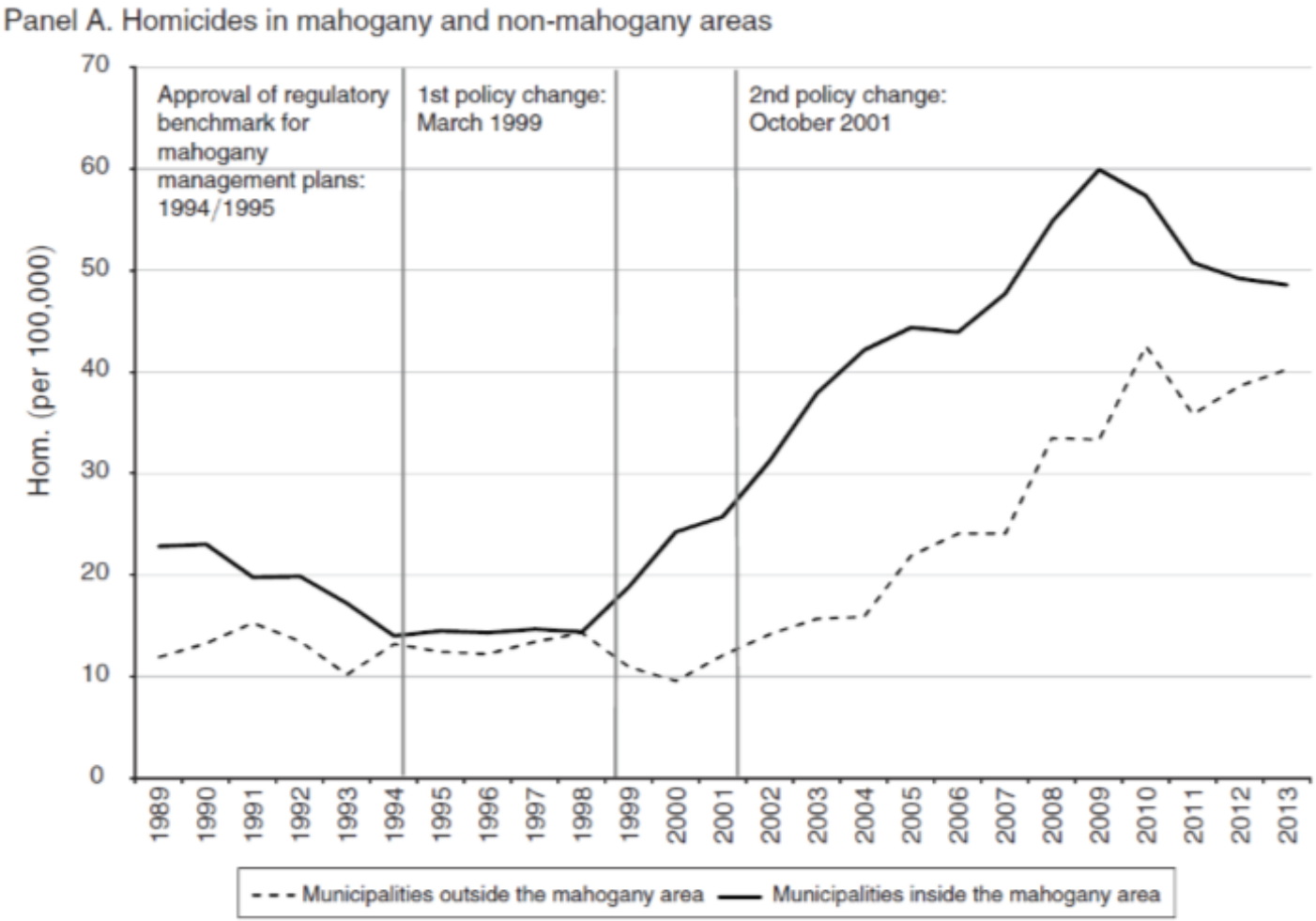
Chimeli and Soares 2017

- Methodology:

$$Homicides_{it} = \gamma_t + \delta_i + \beta(Post-1998_t * Mahogany_i) + \epsilon_i$$

- Cluster standard errors by municipality
- Apply more complex state-specific trends for covariates to minimize risk of non-parallel trends
- Supporting evidence: The 'extra' homicides were the type we'd expect from illegal activity

Difference-in-Differences



Chimeli and Soares 2017

- Interpretation
  - Illegal activity prevents ’peaceful’ contract enforcement
  - Competition between loggers
  - Contract enforcement with buyers
  - Intimidation of communities to not report logging