FLS 6441 - Methods III: Explanation and Causation

Week 8 - Difference-in-Differences

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April 2020

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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1. **Cross-sectional:** Compare outcomes across different units, **treated** and **control**
   - BUT Omitted variable bias
2. **Time-series:** Compare outcomes of 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* fixed characteristics

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Difference-in-Differences

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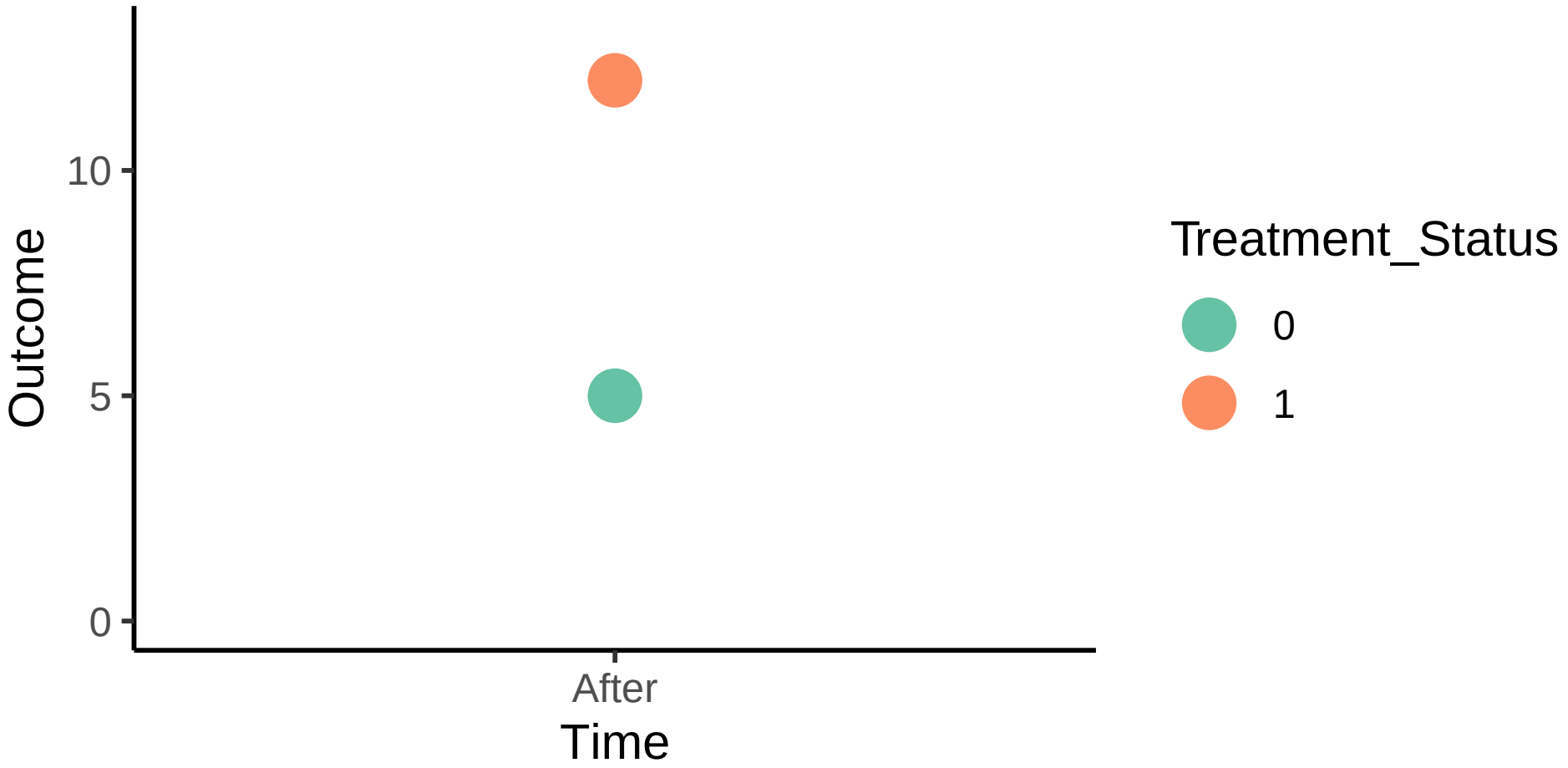
- Comparing **across units** and **across time**
- Comparing **changes** instead of **levels**
- Removing the risks from both overall trends and omitted variables

Difference-in-Differences



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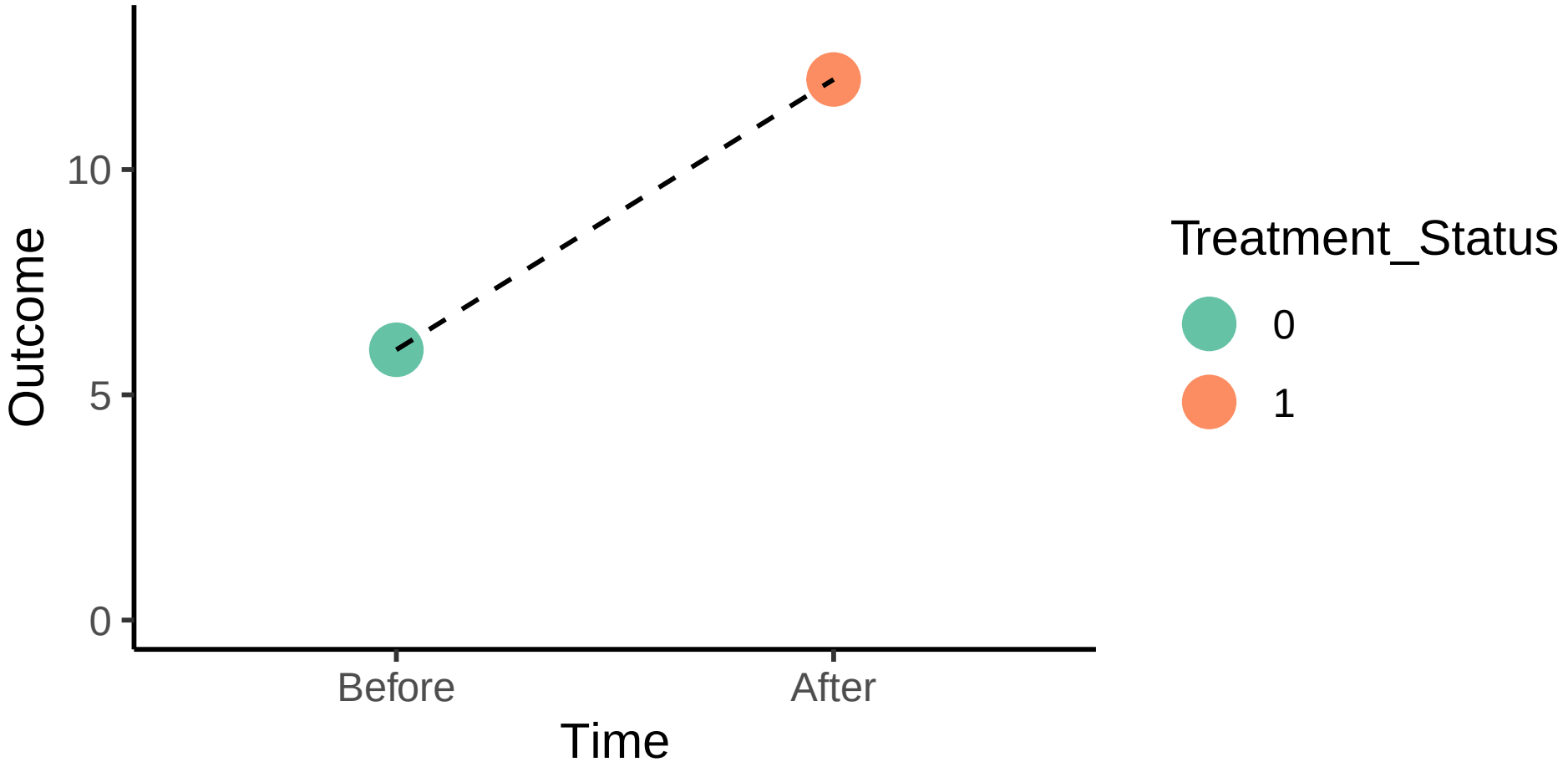

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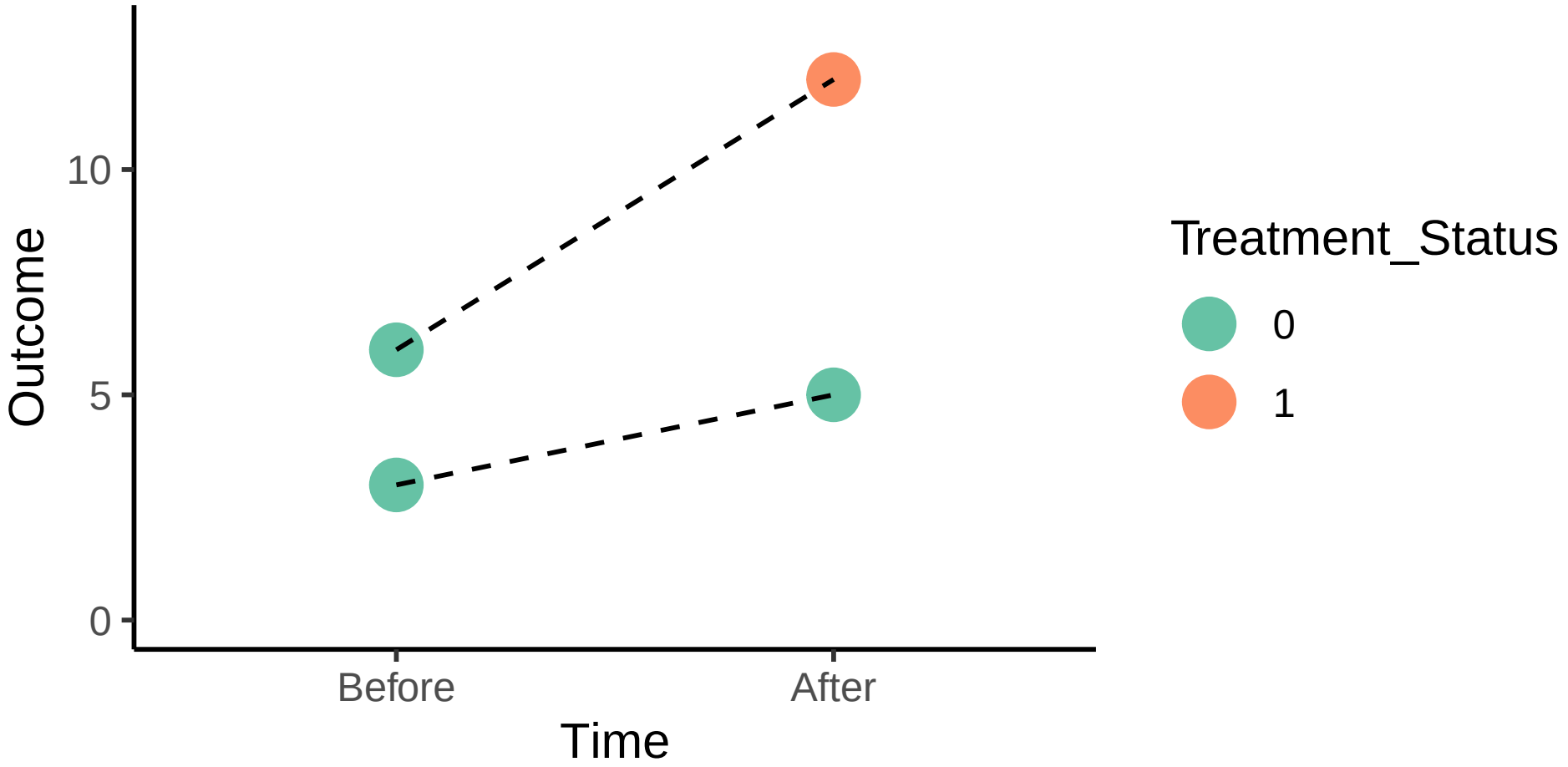

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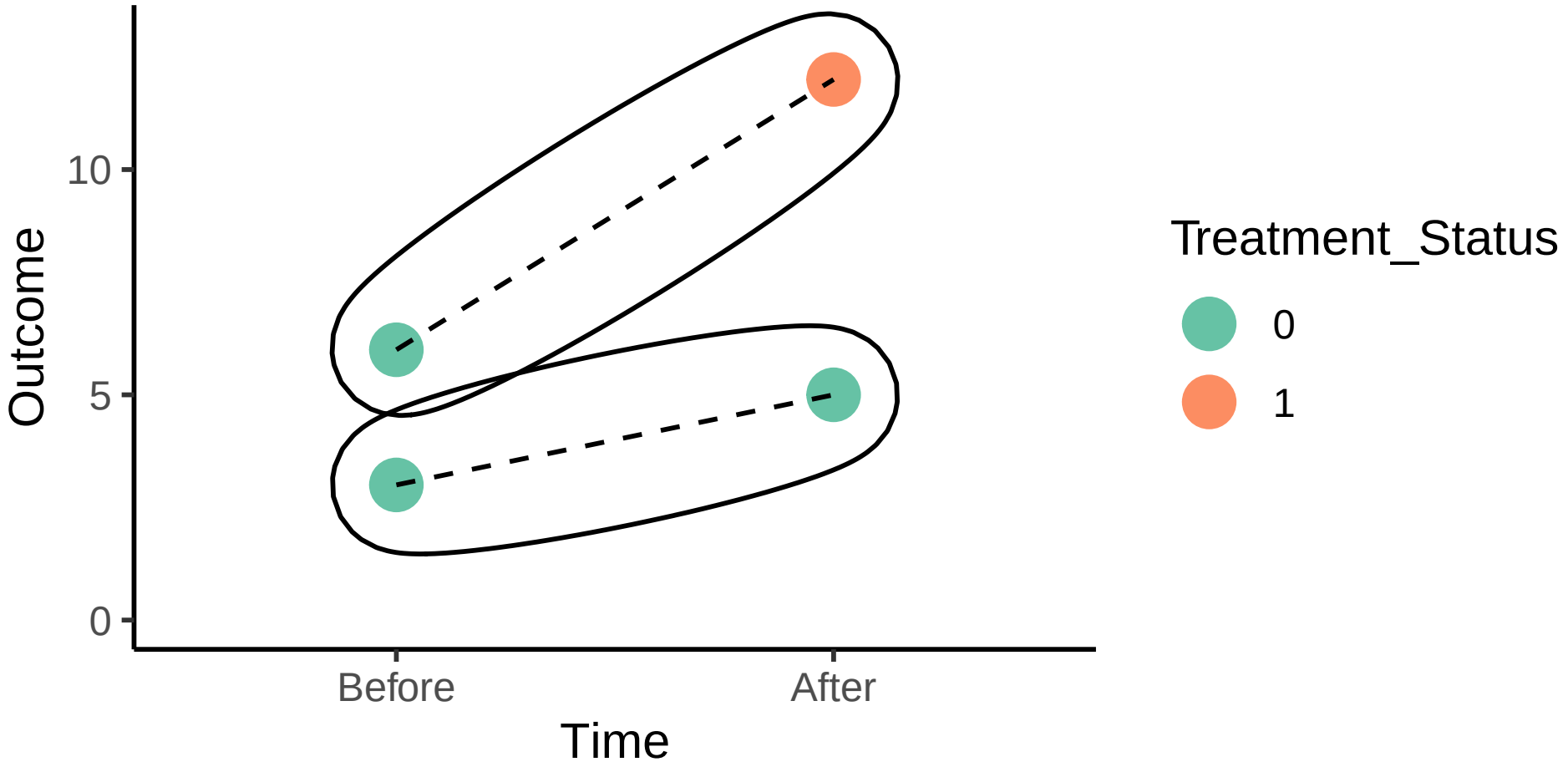

Difference-in-Differences

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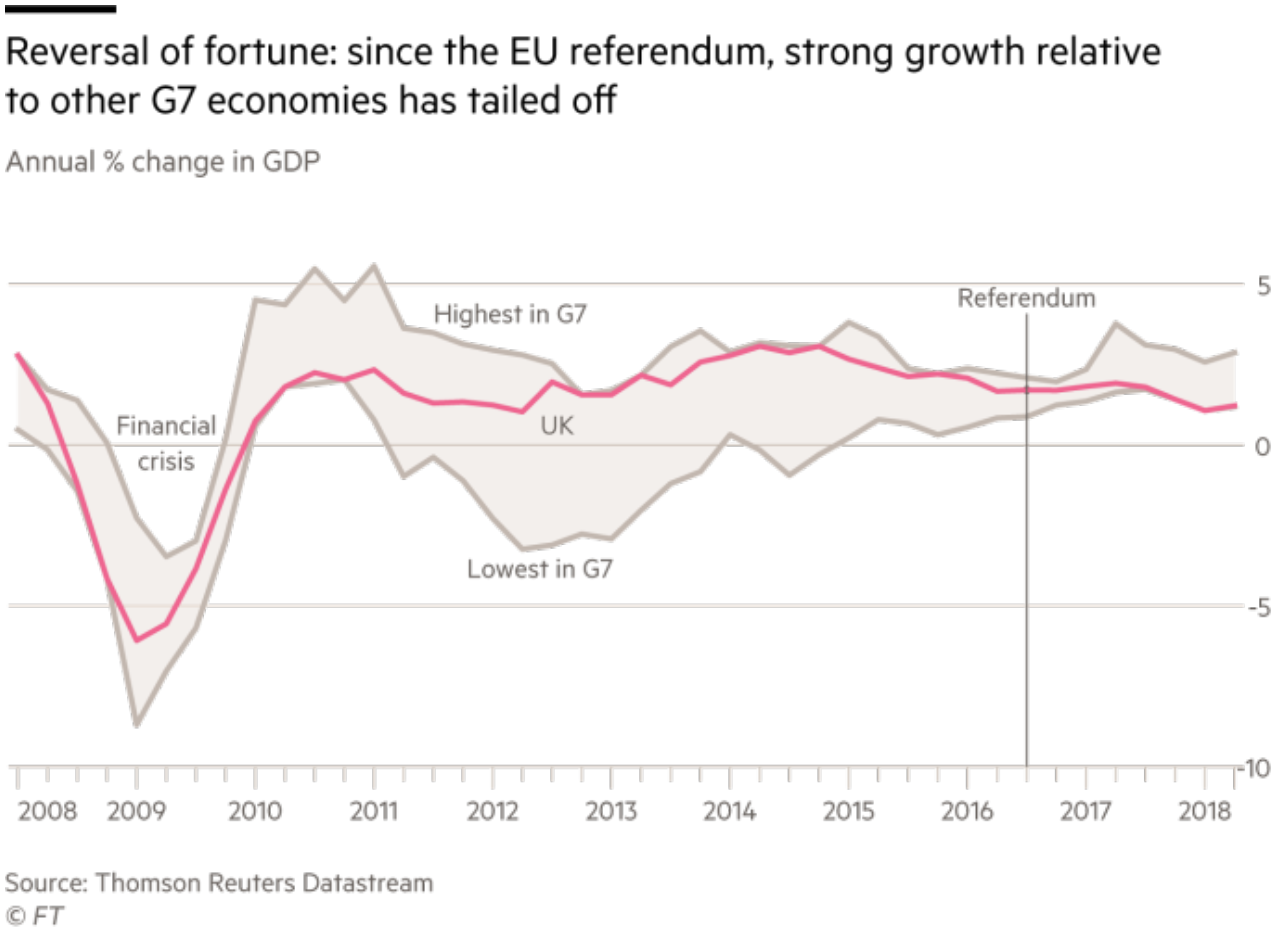
  - Comparing before and after the Brexit vote is biased - the world economy improved around the same time as Brexit (coincidentally)
  - But compare how European growth **changed** (+0.3%) and UK growth **changed** (-0.4%)
  - The net effect of Brexit is -0.7%

Difference-in-Differences



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   - We have to check there are no **compound treatments**

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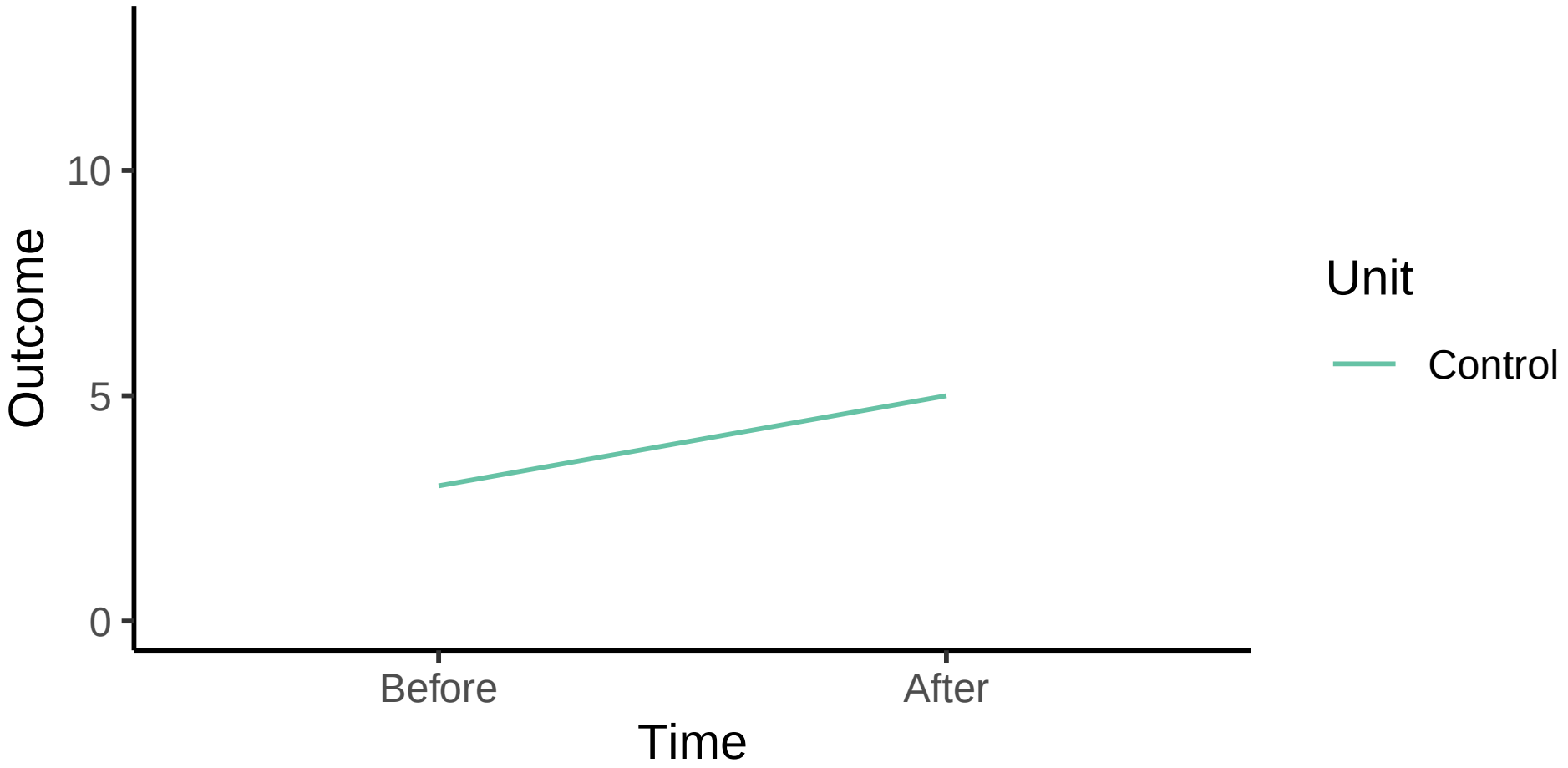

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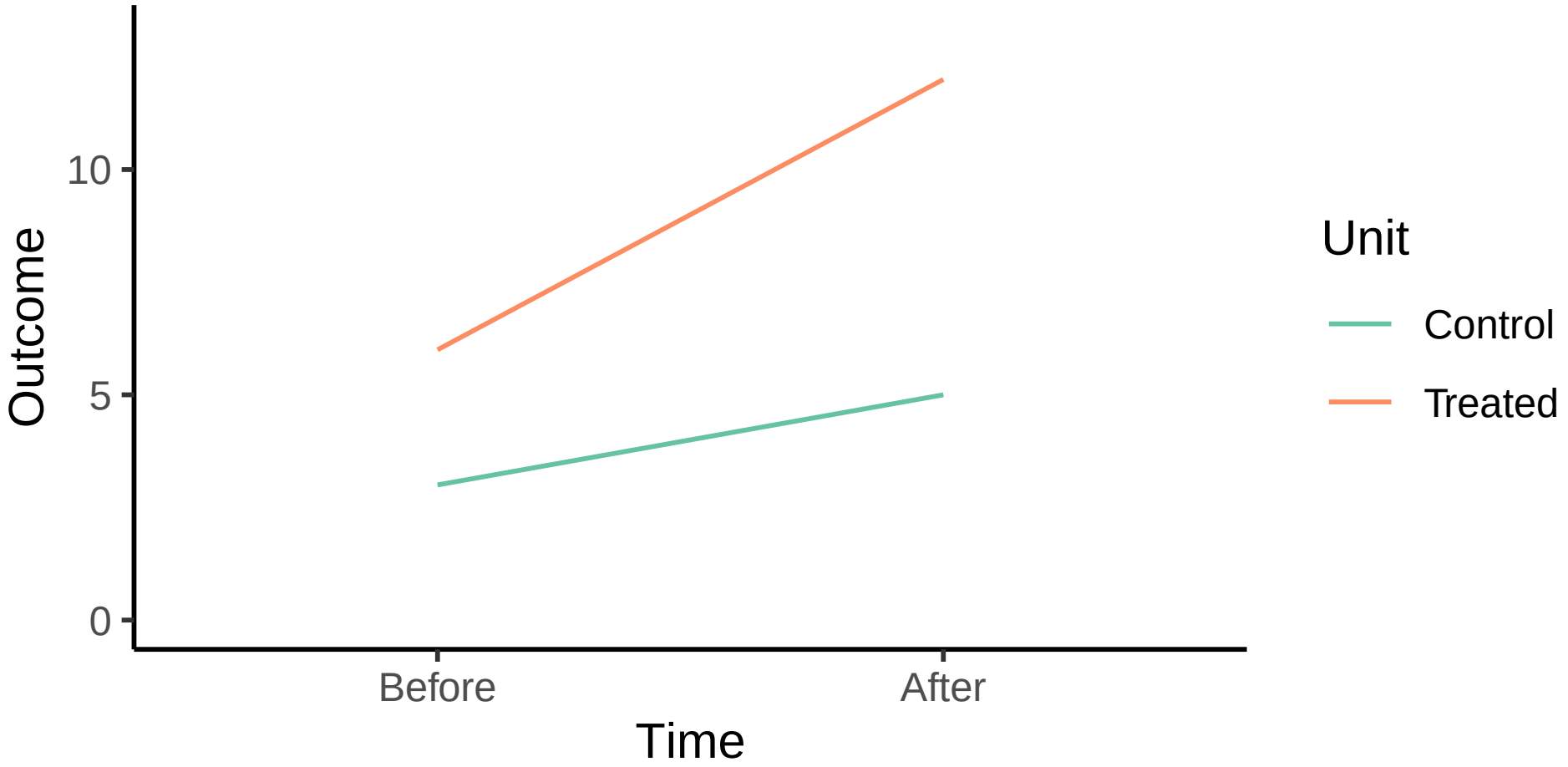

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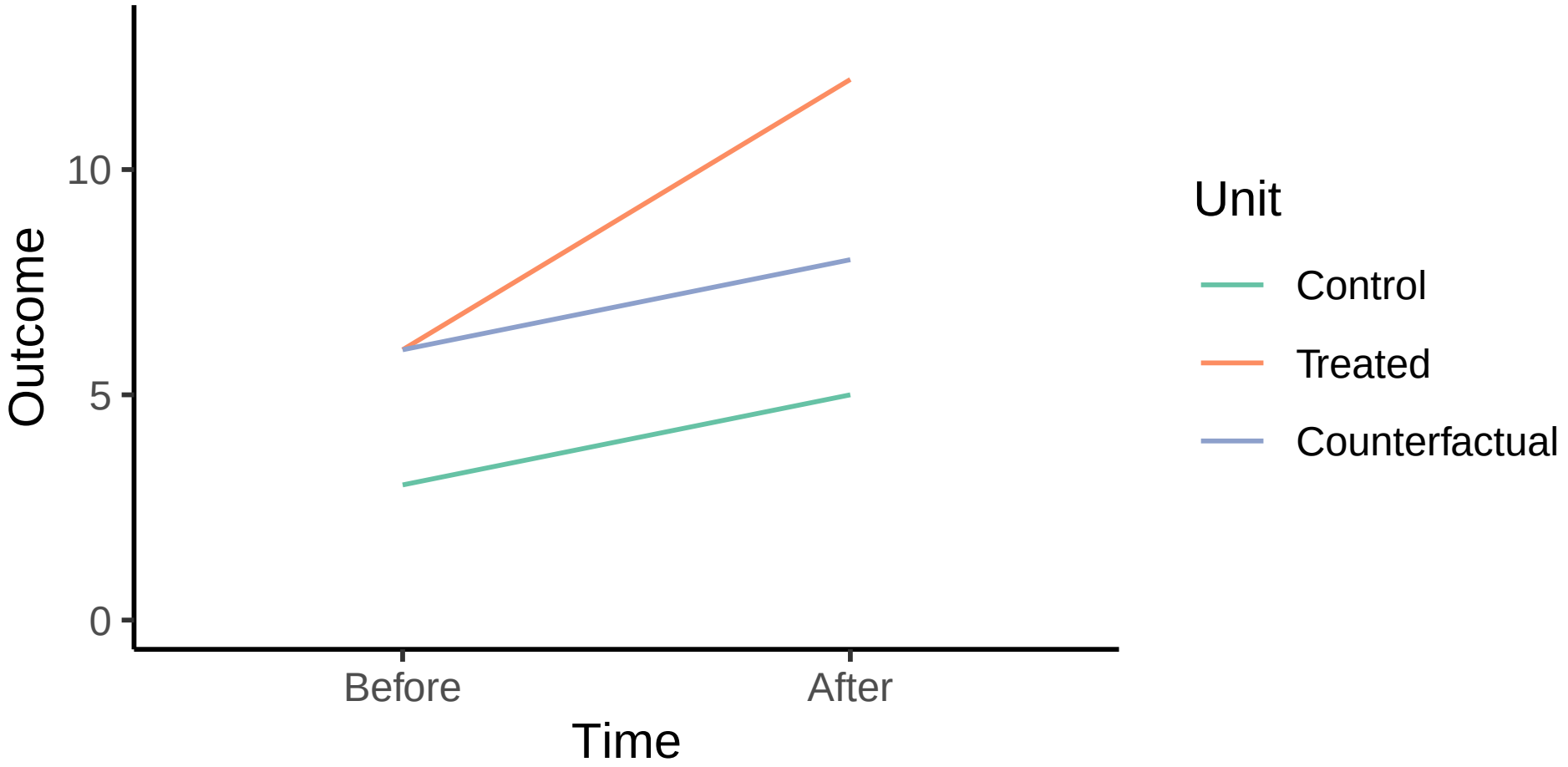

Estimating Difference-in-Differences

- Regression for the cross-unit effect of being a treated unit

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

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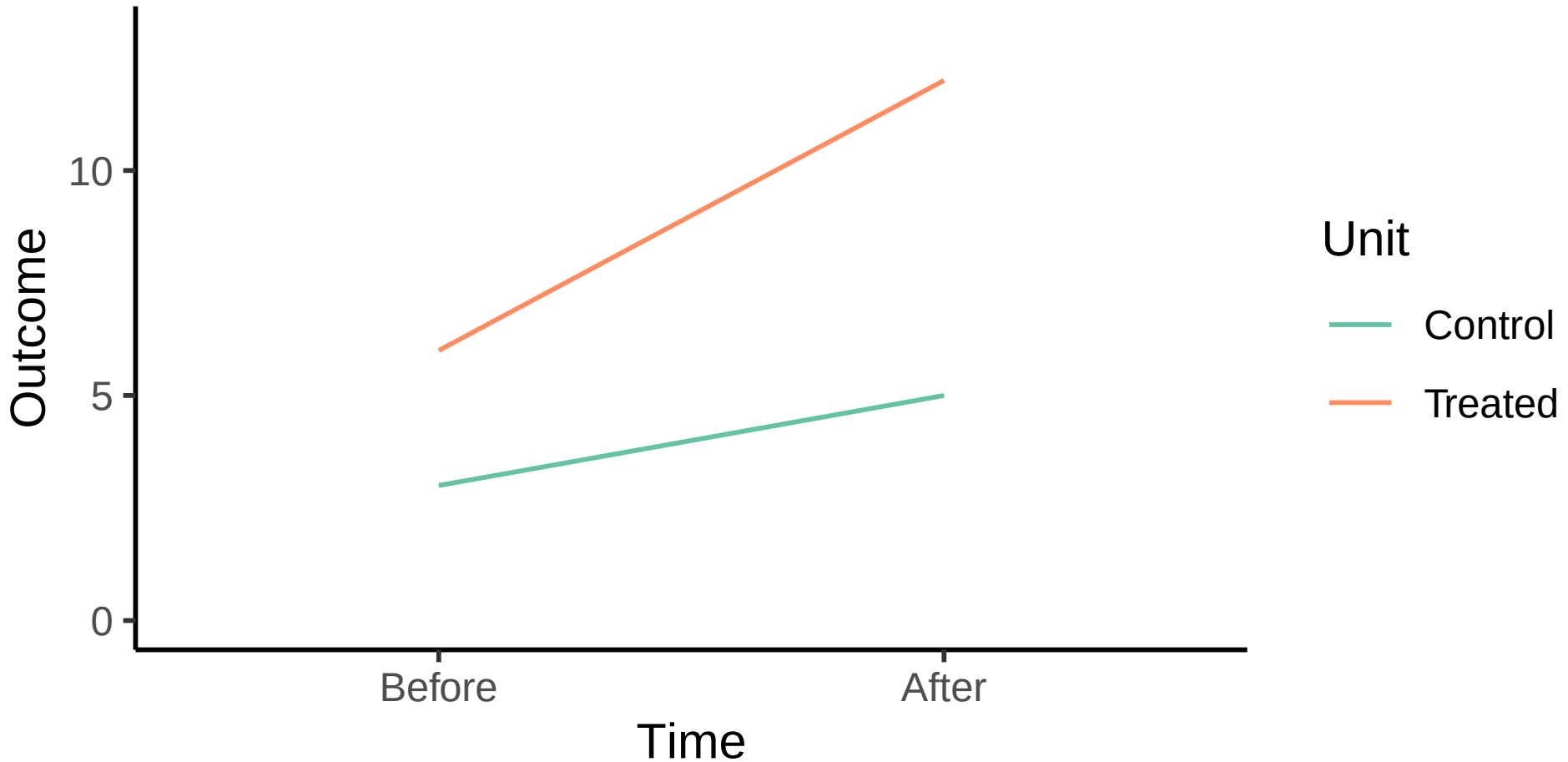
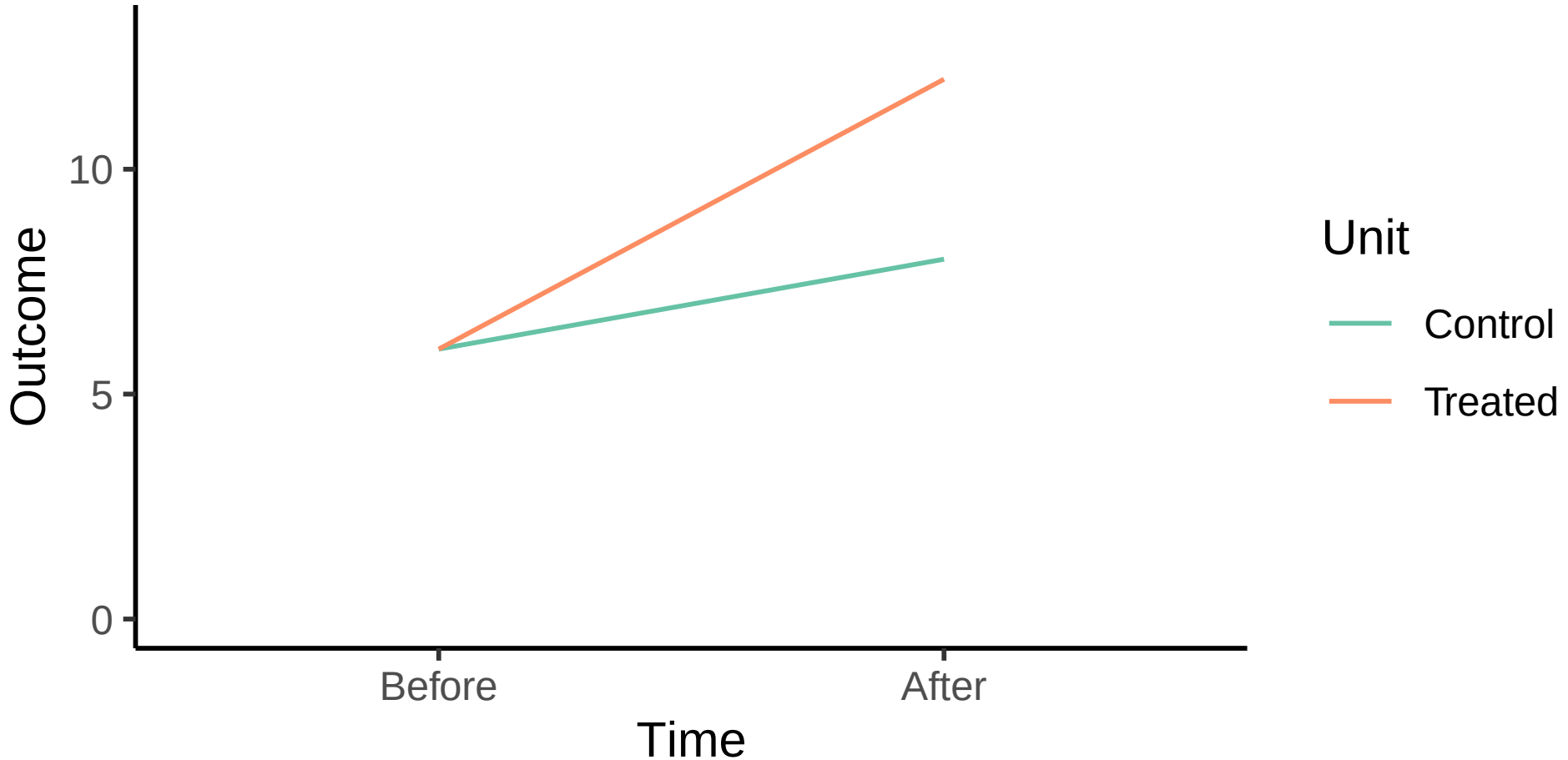
Difference-in-Differences

Raw Data:



Difference-in-Differences

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



Difference-in-Differences

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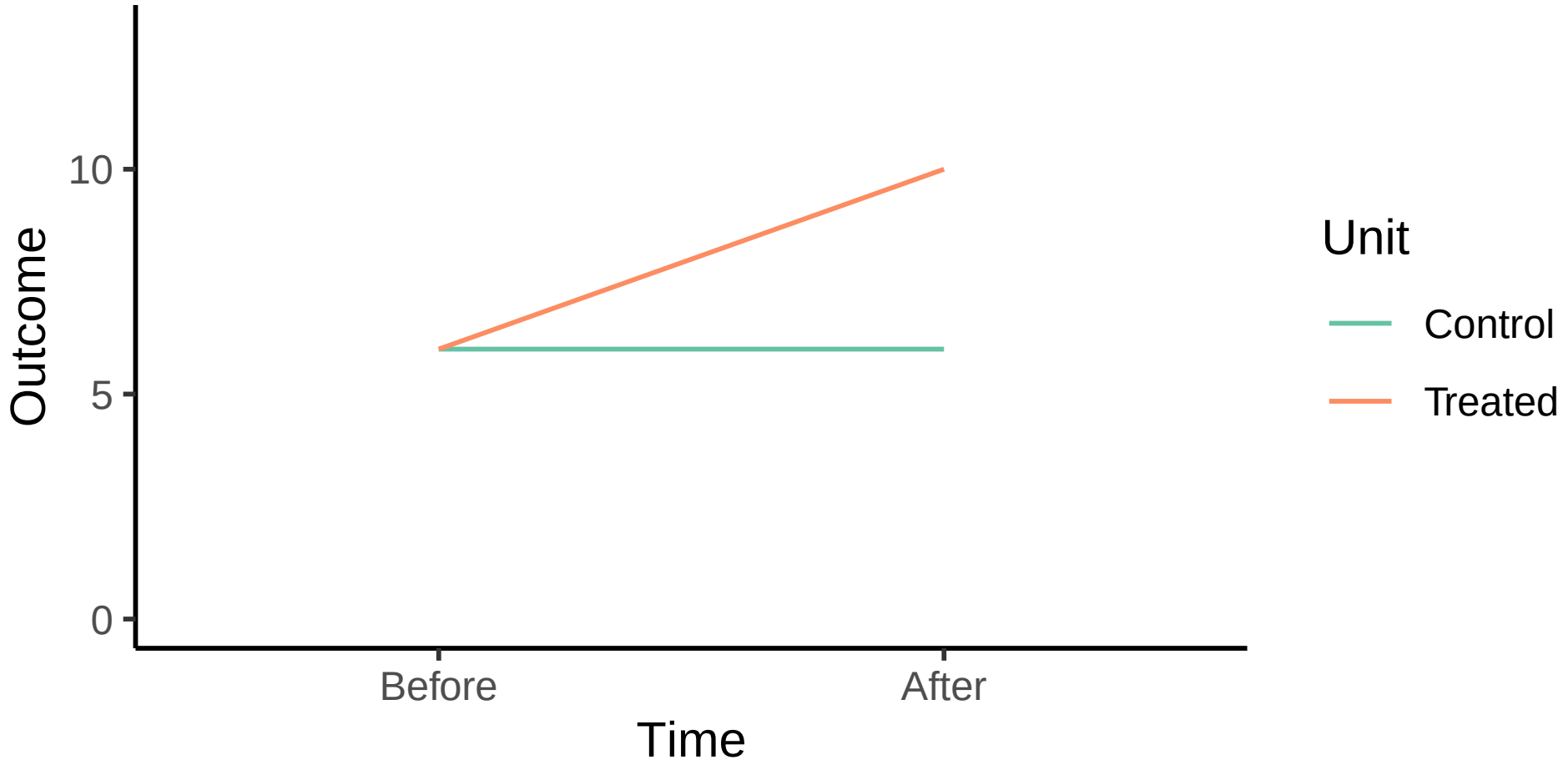

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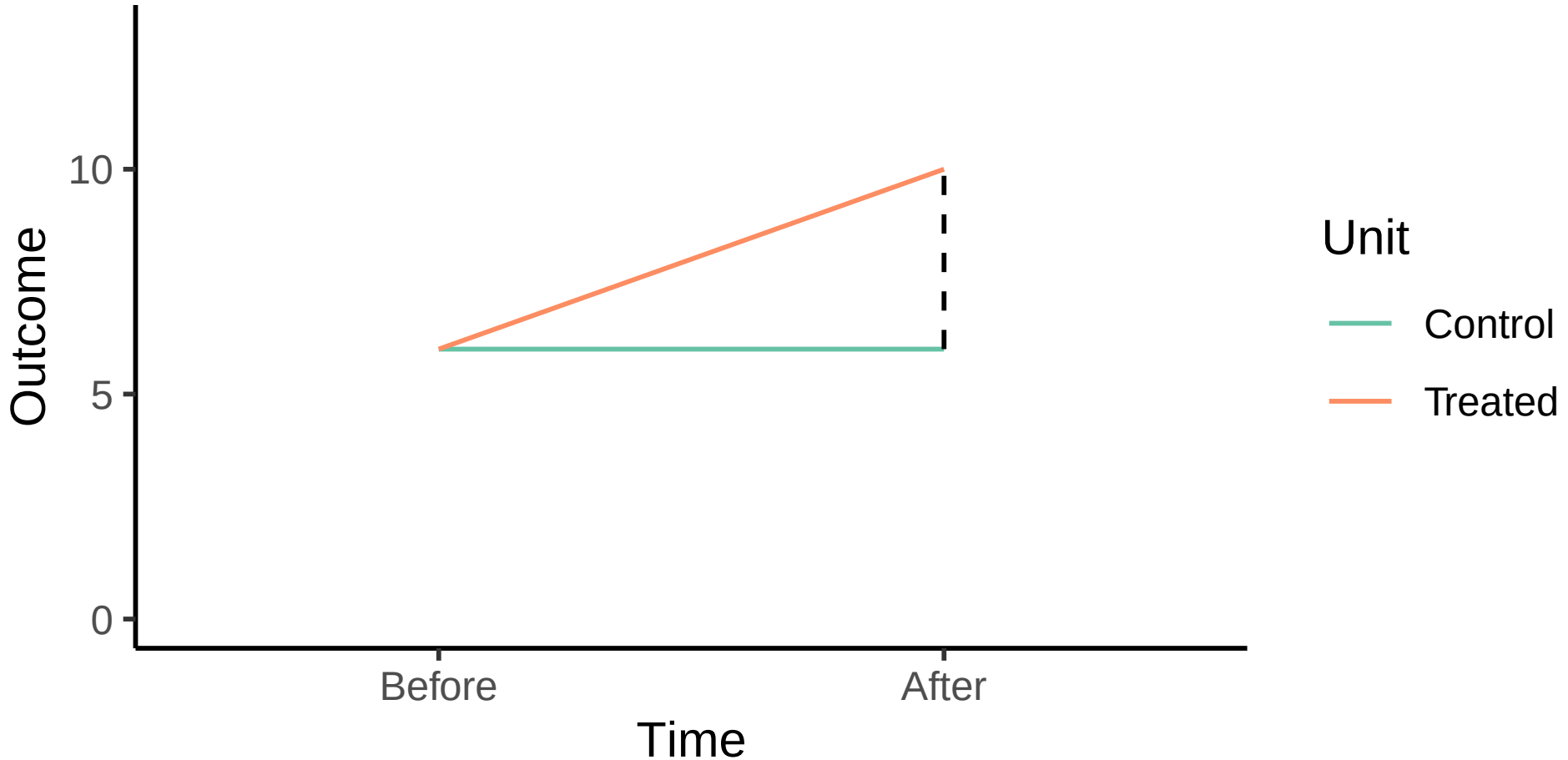

Estimating Difference-in-Differences

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Estimating Difference-in-Differences

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- Crucial to cluster standard errors by each cross-sectional unit (eg. each country)

Difference-in-Differences

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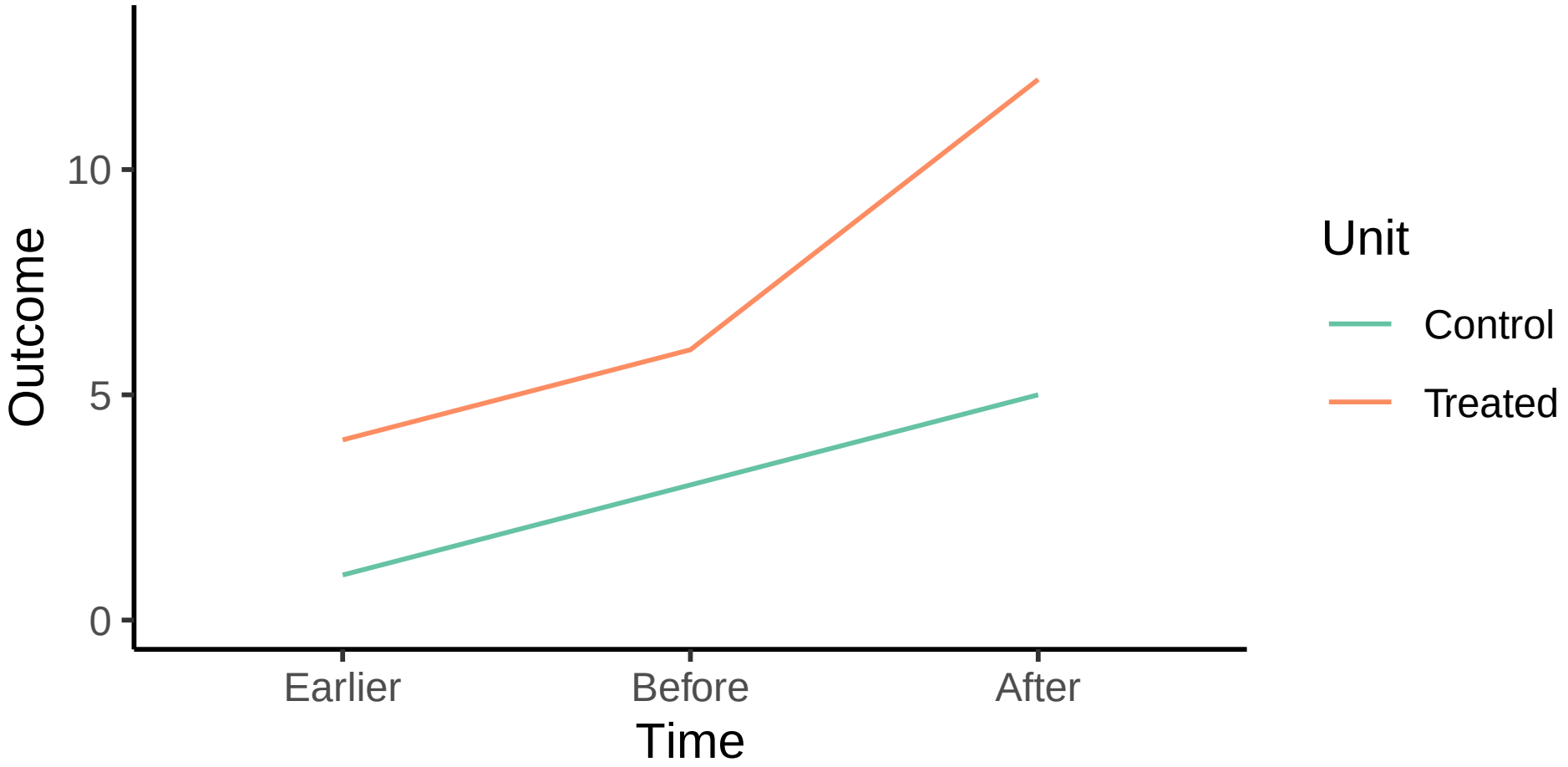
- One test of this is to check if **pre-treatment trends are parallel**

Difference-in-Differences



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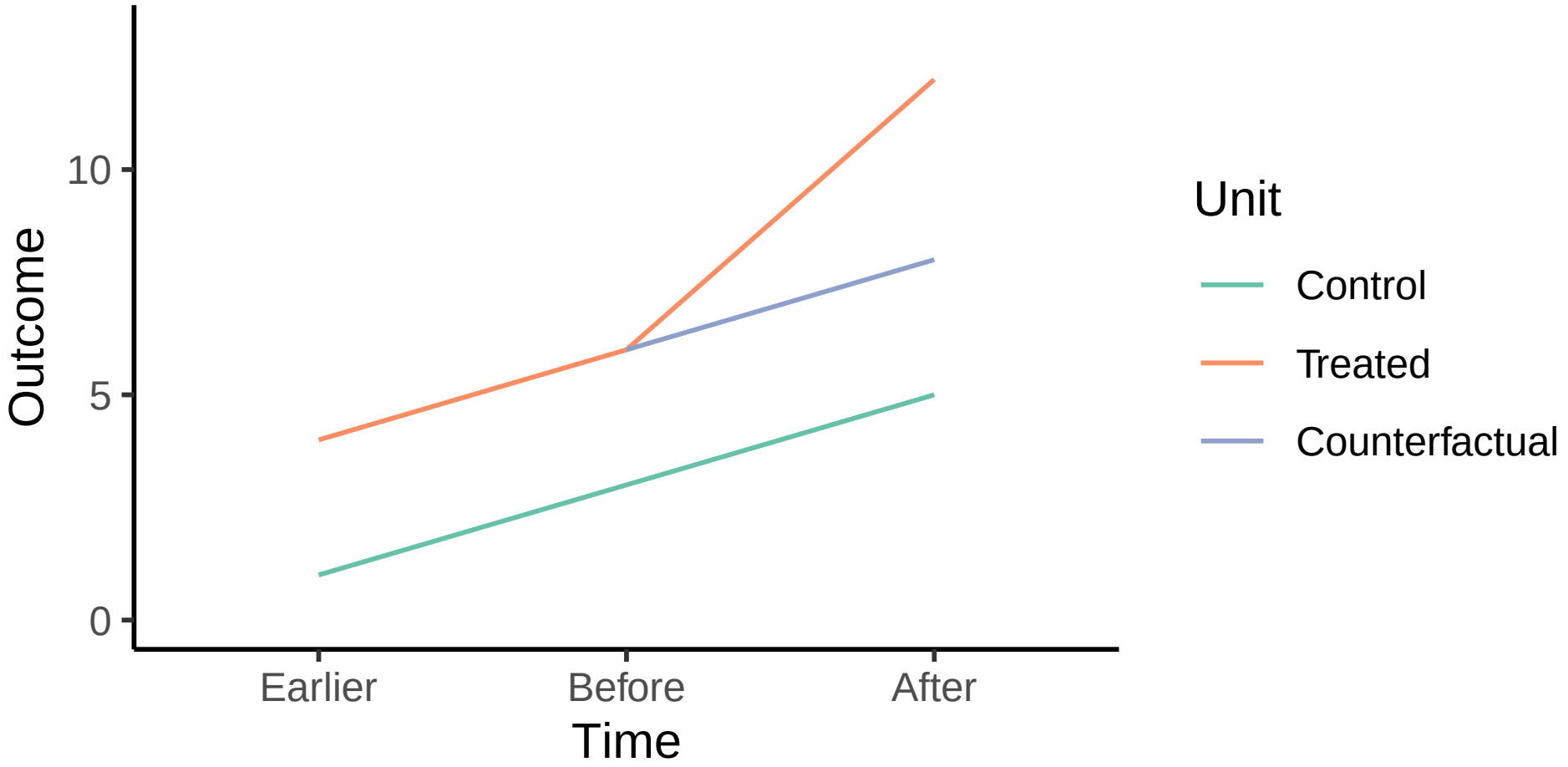

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3. **No spillovers** (SUTVA)
4. **Group membership is stable** (no migration from control to treatment)

Difference-in-Differences

	Time-invariant characteristics	Time-varying characteristics	
	Balances 'fixed' cross-sectional characteristics	Balances Overall Time Trends	Balances Unit-specific trends
Field Experiments	✓	✓	✓
Survey and Lab Experiments	✓	✓	✓
Natural Experiments	✓	✓	✓
Instrumental Variables	✓	✓	✓
Regression Discontinuity	✓	✓	✓
Cross-sectional comparisons	X	✓	X
Before-After comparisons	✓	X	X
Difference-in-Differences	✓	✓	X

Section 2

The Effect of Illegal Activities on Violence

Chimeli and Soares 2017

- How does making an activity illegal affect violence?

Chimeli and Soares 2017

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Chimeli and Soares 2017

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Chimeli and Soares 2017

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- 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-mahogany areas

Chimeli and Soares 2017

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Chimeli and Soares 2017

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

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- **Control:** Municipalities **without** mahogany
- **Before:** Pre-1999

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- **Outcome:** Homicides per 100,000 people

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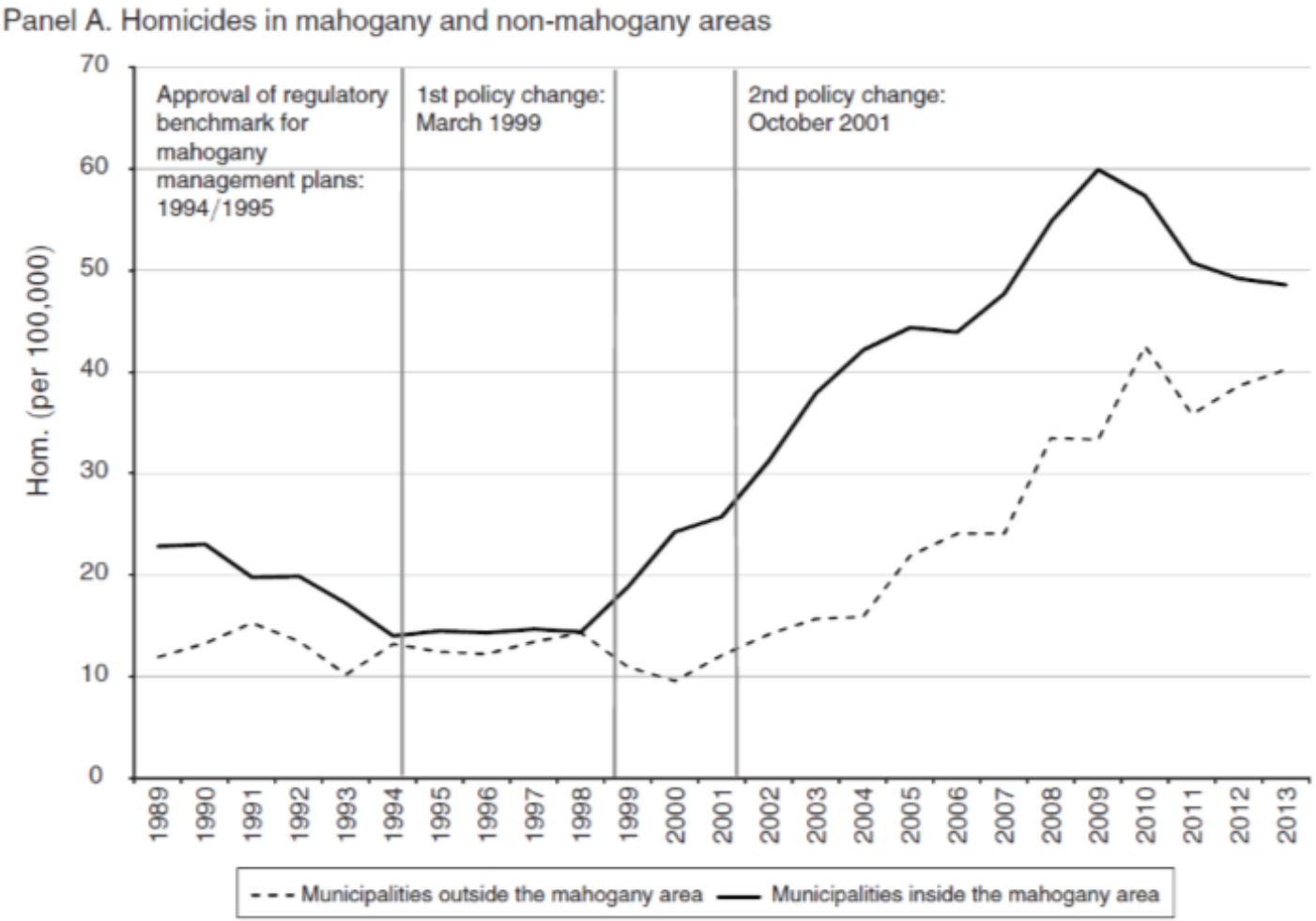
- Multiple treatment timings:
  - Partial Ban on Mahogany exports
  - Full Ban on Mahogany exports
  - 'Reverse' treatment: Better policing of mahogany regulations

Difference-in-Differences



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- Methodology:

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$$Homicides_{it} = \beta_1 Post1999_t + \beta_2 Mahogany_i + \beta_3 (Post1999_t * Mahogany_i) + \epsilon_i \quad (1)$$

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- Apply more complex state-specific trends for covariates to minimize risk of non-parallel trends
  - Not quite unit-specific, but better than nothing

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- Cluster standard errors by municipality
- Apply more complex state-specific trends for covariates to minimize risk of non-parallel trends
  - Not quite unit-specific, but better than nothing
- Supporting evidence: The 'extra' homicides were the type we'd expect from illegal activity

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TABLE 2—ILLEGALITY OF MAHOGANY TRADE AND HOMICIDES, 1995–2013, DIFFERENCE-IN-DIFFERENCE BENCHMARK RESULTS

	Municipalities in states with mahogany occurrence					
					Triple-diff:	
Variables	(1)	(2)	(3)	Treatments interacted with linear trends (4)	State percent in exp. before 1999 (5)	Suspect. state exp. after 1999 (6)
treat 1999	4.520	8.078	5.946	5.669	17.13	0.0994
	[2.627]	[2.841]	[2.031]	[2.586]	[6.078]	[0.0370]
treat 1999 × trend				2.409		
				[1.398]		
treat 2002	7.034	15.03	12.68	15.11	31.13	0.139
	[3.491]	[3.633]	[3.650]	[3.321]	[7.517]	[0.0303]
treat 2002 × trend				−0.0275		
				[0.556]		
treat 2009	−1.478	9.514	10.81	14.29	22.52	0.371
	[4.521]	[4.207]	[4.173]	[5.369]	[9.228]	[0.146]
treat 2009 × trend				−2.387		
				[1.023]		
State FE × year FE		X	X	X	X	X
Baseline charact. × year FE			X			
Observations	11,932	11,932	11,533	11,932	11,932	11,932
R^2	0.645	0.709	0.772	0.710	0.712	0.711

Notes: Robust standard errors are in brackets (clustering at municipality). Dependent variable is the homicide rate (per 100,000 inhabitants). All regressions include a constant, municipality, and year dummies, and are weighted by population. Treatment variables are dummies = 1 between 1999–2001, between 2002–2008, and after 2008 interacted with: dummy of mahogany-occurring area (columns 1–4); state share in total pre-1999 mahogany exports × dummy of mahogany occurring area (column 5); sum of state exports of mahogany and "other tropical timber species" (which we call "suspected state exports after 1999") × dummy of mahogany occurring area (column 6). Columns 2 to 6 control for state-specific time dummies. Column 3 controls for interactions of year dummies with baseline (1995) values of the following municipality characteristics: percent of area planted, mortality by heart and circulatory diseases, neoplasms, infectious diseases, traffic accidents, suicides, child mortality, assassinations related to land conflicts (rate), per capita GDP (ln), fraction of GDP in agriculture (the latter 2 measured in 1996),

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- Testing for Pre-treatment trends:

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- Testing for Pre-treatment trends:
  - A 'Placebo' treatment in 1997/8: No effect

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- Also try a low-powered test with unit-specific time trends

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- Testing for Pre-treatment trends:
  - A 'Placebo' treatment in 1997/8: No effect
- Also try a low-powered test with unit-specific time trends
  - Doesn't change the results

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TABLE 4—ILLEGALITY OF MAHOGANY TRADE AND HOMICIDES, TESTING FOR PARALLEL TRENDS AND OTHER EFFECTS OF REGULATORY CHANGE, MUNICIPALITIES IN PARÁ, DIFFERENCE-IN-DIFFERENCE

	Effect on homicides and parallel trends, 1995–2013		Other economic changes, data restricted to 1996, 1999–2010					
	Testing for pre-trend	Municipality linear trend	Dependent variable: Homicide		Dependent variable: GDP per capita		Dependent variable: Percent GDP in agric.	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
treat 1999	13.55	14.07	10.44	8.577	0.322	0.256	0.0515	0.0823
	[6.021]	[4.345]	[3.384]	[5.018]	[0.134]	[0.145]	[0.0594]	[0.0594]
treat 2002	23.45	25.96	20.35	16.16	0.461	0.312	0.0182	0.0874
	[6.262]	[5.820]	[4.989]	[7.363]	[0.166]	[0.174]	[0.0648]	[0.0607]
treat 2009	17.35	22.24	20.94	14.65	0.431	0.207	−0.00712	0.0967
	[7.062]	[6.144]	[8.091]	[7.293]	[0.164]	[0.192]	[0.0725]	[0.0644]
Placebo	1.728							
	[4.374]							
Municipality specific trend		X		X		X		X
Observations	2,432	2,432	1,664	1,664	1,664	1,664	1,664	1,664
R^2	0.731	0.801	0.776	0.855	0.942	0.966	0.851	0.916

Notes: Robust standard errors are in brackets (clustering at municipality). Dependent variable is the homicide rate (per 100,000 inhabitants) in columns 1–4, the log of GDP per capita in columns 5–6, and the share of GDP in agriculture in columns 7–8 (the latter 2 only available for 1996, 1999–2010). All regressions include a constant, municipality, and year dummies, and are weighted by population. Treatment variables are dummies = 1 between 1999–2001, between 2002–2008, and after 2008 interacted with the dummy of the mahogany-occurring area. Pre-1999 placebo is a dummy for 1997–1998 interacted with mahogany occurring area. Columns 2, 4, 6, and 8 include, as additional controls, interactions of municipality dummies with a linear time trend.

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- Interpretation

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- Interpretation
  - Illegal activity prevents ’peaceful’ contract enforcement

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  - Competition between loggers

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  - Illegal activity prevents ’peaceful’ contract enforcement
  - Competition between loggers
  - Contract enforcement with buyers

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