Causal inference in Financial Event Studies

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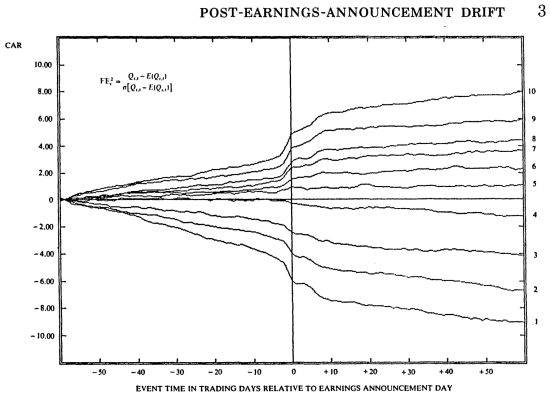
This is a paper tying two literatures together

- Finance literature studying the impact of events on financial asset prices
- Econometrics literature estimating the average treatment effect on the treated using model and design-based inference
- Goal for today's talk:
  1. Highlight a rich set of applications in finance that are natural settings for causal inference
  2. Discuss some straightforward takeaways for why existing methods in finance tend to be irrelevant
  3. Discuss some potential ways to improve the discussion identification of treatment effects in finance
- Will present some simulations + an application where we show how different methods can lead to different conclusions

Finance literature studying the impact of events on financial returns

What types of financial events? Examples...

- Earnings Announcements
- S&P 500 Inclusion
- Mergers and acquisitions
- IPO, SEO, Share repurchased
- CEO/CFO Changes
- Patent Issuance
- FOMC Announcements
- Labor Issues
- Political events



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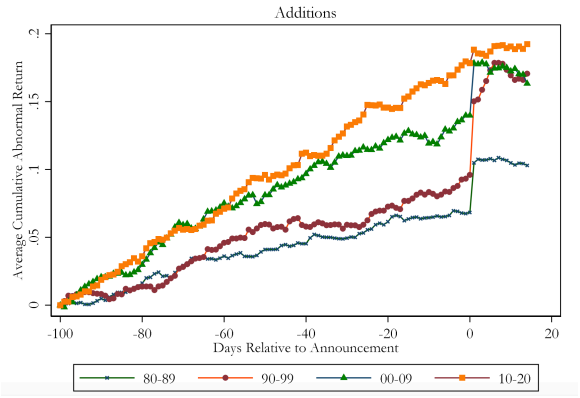

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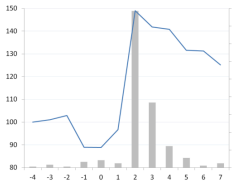

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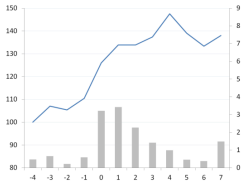

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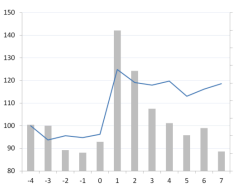

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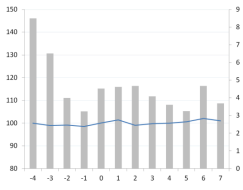

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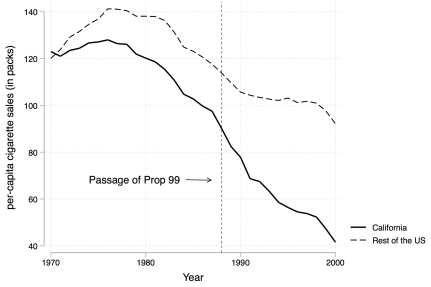
Econometrics literature estimating the average treatment effect on the treated

- Researchers interested in estimating the average treatment effect on the treated
- Can use a model of the counterfactual $E(Y_i(0)|D_i = 1)$
- E.g. Difference-in-difference:
  - Parallel trends implies a model of $E(Y_i(0)|D, T) = \alpha + \beta D + \gamma T + \delta(D \times T)$
  - Can use this *model* to impute the counterfactual
- New synthetic control methods having a renaissance but most applications are on low-frequency slow-moving outcomes:
  - State Annual Tobacco Consumption
  - State GDP Growth
  - Annual Country GDP Growth



Abadie and Gardeazabal (2003) use synthetic control for GDP growth, but not for stock return analysis!

Simple example with notation (single event timing)

- Let $G_i \in \{0, 1\}$ denote whether a firm i is affected by an event at time t_0
- Let $r_{it}(g)$ denote the return for asset i in period t depending on treatment
  - Note no restrictions on timing
- Effect of the event for firm i at time t is: $\tau_{it} = r_{it}(1) - r_{it}(0)$
- The average treatment effect on the treated is:

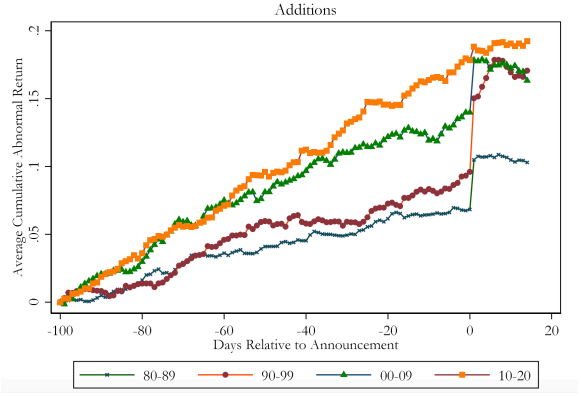
$$\tau_t = E_t(\tau_{it}|G_i = 1) = E_t(r_{it}|G_i = 1) - E_t(r_{it}(0)|G_i = 1) \quad (1)$$

- Is it possible to idenitfy τ_{it} or τ_t?

What is done in finance to estimate τ_{it} and τ_t?

- Consider S&P 500 index inclusion as an event
  - Recent paper by Greenwood and Sammon (2024), many others (original papers by Shleifer (1986) and Harris and Gurel (1986))
- Researchers focus on *abnormal returns*

$$
\begin{aligned}
AR_{it}^{mkt} &= r_{it} - r_t^{mkt} \\
AR_{it}^{capm} &= r_{it} - \hat{\alpha}_i - \hat{\beta}_i^{mkt} r_t^{mkt} \\
AR_{it}^{ff} &= r_{it} - \hat{\alpha}_i - \sum_k \hat{\beta}_{ik} f_{kt}
\end{aligned}
$$



What is done in finance to estimate τ_{it} and τ_t?

- Patent announcments (Kogan et al. (2017)) is another example
- When do *abnormal returns* identify τ_{it} and τ_t?

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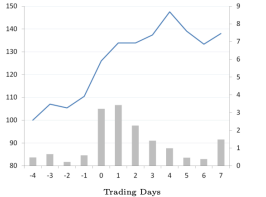

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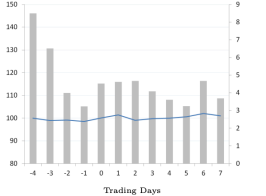

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What types of conditions identify τ_{it} and τ_t?

- In the finance literature, formal conditions on G_i are rarely discussed. Typically assumed:
  - No arbitrage: r_t^{mkt} or $\hat{\alpha}_i + \hat{\beta}_i F_t$ is a good estimate for $E(r_{it}(0)|G_i = 1)$
  - No leakage: $E(AR_{it}) = 0$ for $t < t_0$
- No arbitrage motivated by Ross (1976) and Chamberlain & Rothschild (1983) – expected returns can be modeled in short-run as linear factor structure

$$E(r_{it}) = \alpha_i + \beta_i' F_t \tag{2}$$

What types of conditions identify τ_{it} and τ_t?

- Assume that the linear factor model holds:

$$r_{it} = \alpha_i + \mathbf{F}_t'\beta_i + G_i'\tau_{it} + \varepsilon_{it} \tag{3}$$

- If F_t is observed, we can identify $\tau_{it} + \varepsilon$ and $E(\tau_{it})$
  - Need sufficiently long panel to estimate β_i and α_i
- But, is $G_i'\tau_{it}$ correlated with $\mathbf{F}_t'\beta_i$? E.g. can we use

$$r_{it} = \alpha_i + G_i'\tau_{it} + \underbrace{u_{it}}_{\mathrm{F}_t'\beta_i + \varepsilon_{it}} \tag{4}$$

- Standard omitted variables bias question: are the firms treated by the event different in terms of their factor loadings?

Model-based vs. design-based approach?

- Standard finance approach mirrors model-based approach in difference-in-difference
  - Construct a counterfactual using a model of returns
- However, returns are a natural setting for "synthetic" models
  - Many potential control units, long panel, plausible underlying factor model
  - However, lukewarm evidence about efficacy of synthetic models (Castro-Iragorri (2019) and Baker and Gelbach (2020)). Why?
- In fact, often researchers find limited differences in using different types of models to generate abnormal returns in short run.
- Reflects several possible features:
  - Factors may explain small amount of outcome variance?
  - Treatments are effectively randomly assigned?
  - Treatment *timing* is effectively randomly assigned?

Structure of problem

1. Single vs. staggered events
2. Single vs. multiple treated units
3. Event randomly assigned to units

- Today: show simulations for single event case
- Then: application with strong selection with large factor shocks and many units

Simulation setup

- Sample of U.S. firms drawn from 2001-2020. Focus on panel of present throughout full sample.
- Randomly sample firms and days, and randomly allocate treatment to firms
  - Treatment effect is 3% on single day of event
  - Treatment is either random for firms, or correlated with $\beta_i^{mkt} r_t^{mkt}$ for the event day
- Consider five estimators: simple mean returns, CAPM, Fama-French factors, Gsynth (Xu and Liu (2022)), Augsynth (Ben-Michael, Feller & Rothstein (2021)) using synth approach

Under random assignment with many units and single event, simple means is fine...

	All Periods		Treated Periods		Untreated Periods	
Model	E(Bias)	RMSE	E(Bias)	Coverage	E(Bias)	Coverage
Simple Means	0.00	1.50	0.02	1.00	0.00	0.06
CAPM	0.02	1.30	0.05	1.00	0.02	0.05
Fama-French Factors	0.02	1.30	0.05	1.00	0.02	0.05
Gsynth (PCA)	0.02	1.46	0.05	0.99	0.02	0.08
Augsynth (Synth)	0.03	1.54	0.04	0.93	0.03	0.07

- Not much benefit to using lagged outcomes b/c returns follow a random walk (Roth and Sant'anna (2023))
- Simulation Estimates for n=500, n-treated = 50, T=250, one-shot-treatment, Treatment process: randomly assigned

Under random assignment with few treated units and single event, synth is better but not by a lot

	All Periods		Treated Periods		Untreated Periods	
Model	E(Bias)	RMSE	E(Bias)	Coverage	E(Bias)	Coverage
Simple Means	-0.04	4.25	-0.03	0.87	-0.04	0.14
CAPM	0.00	3.87	0.02	0.89	-0.01	0.12
Fama-French Factors	-0.01	3.94	0.04	0.90	-0.01	0.11
Gsynth (PCA)	0.00	4.66	0.05	0.83	-0.01	0.08
Augsynth (Synth)	0.00	3.79	0.03	0.85	0.00	0.07

- Simulation Estimates for n=500, ntreated = 5, T=250, one-shot-treatment, Treatment:random

Under correlated assignment with many units and single event, simple means is fine...

	All Periods		Treated Periods		Untreated Periods	
Model	E(Bias)	RMSE	E(Bias)	Coverage	E(Bias)	Coverage
Simple Means	0.03	1.71	0.14	1.00	0.02	0.09
CAPM	0.00	1.38	0.13	1.00	-0.01	0.07
Fama-French Factors	0.00	1.35	0.12	1.00	-0.01	0.07
Gsynth (PCA)	-0.03	1.23	0.04	1.00	-0.03	0.05
Augsynth (Synth)	-0.02	1.52	0.03	0.92	-0.02	0.07

- Simulation Estimates for n=500, ntreated = 50, T=250, one-shot-treatment, Treatment correlated with market

Under correlated assignment with few units and single event, simple means is biased, but none of the models do great

	All Periods		Treated Periods		Untreated Periods	
Model	E(Bias)	RMSE	E(Bias)	Coverage	E(Bias)	Coverage
Simple Means	0.20	4.27	0.96	0.75	0.13	0.14
CAPM	-0.01	4.10	0.80	0.83	-0.08	0.08
Fama-French Factors	-0.01	4.11	0.85	0.83	-0.09	0.08
Gsynth (PCA)	0.02	4.09	0.67	0.83	-0.04	0.08
Augsynth (Synth)	-0.10	4.31	0.63	0.75	-0.16	0.07

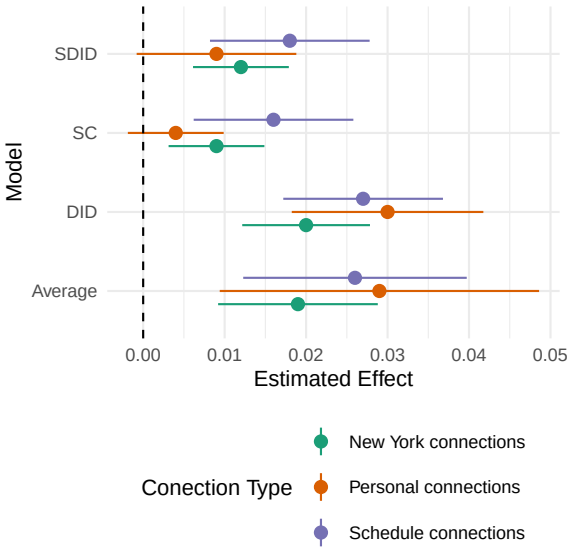
- Simulation Estimates for n=500, ntreated = 5, T=250, one-shot-treatment, Treatment correlated with market

Example: Acemoglu et al. (2016) “The value of connections in turbulent times: Evidence from the United States”

- Acemoglu et al. (2016) study how the leak of Timothy Geithner’s nomination as U.S. Treasury Secretary on Nov 21, 2008 affected firms connected to him
  - Today, focus on pooled average treatment effect (ATT) for four methods: simple means, CAPM, Fama-French factors, Augsynth
- Paper originally compares *within* banks connected vs. not, we also expand to compare connected banks to full set of assets
- Plausible that connected banks are very different than other financial assets (not randomly assigned) and timing is not random either (financial crisis!)

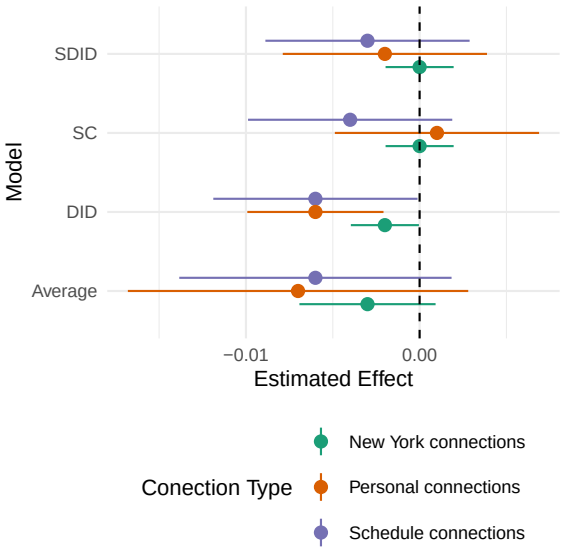
Main estimation approach from paper

- Effect sizes are large in the paper, shrink significantly with synthetic approach



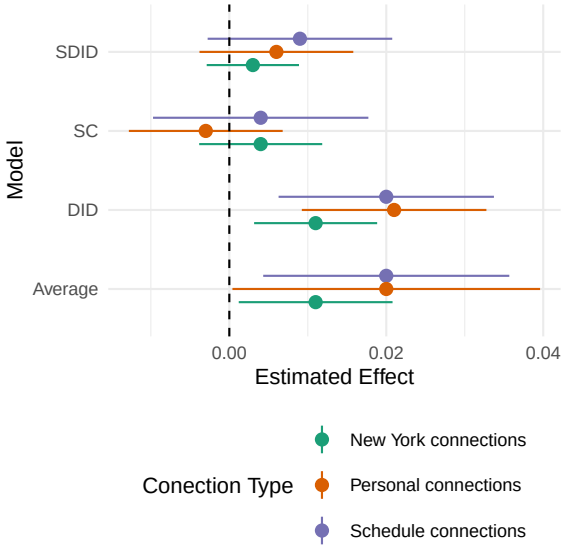
Main estimation approach from paper

- Effect sizes are large in the paper, shrink significantly with synthetic approach
- Effect sizes in paper are potentially high due to pre-trends!



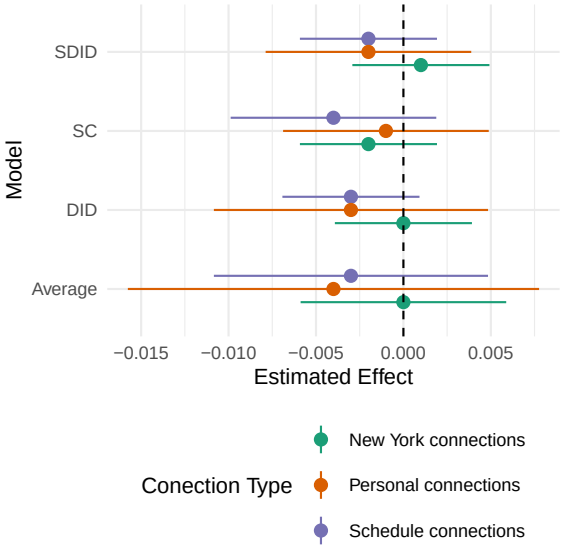
Allowing for a full suite of controls matters

- Using all firms changes the results



Allowing for a full suite of controls matters

- Using all firms changes the results
- Pre-tests suggests SC approach in line with no-anticipation and no-arbitrage



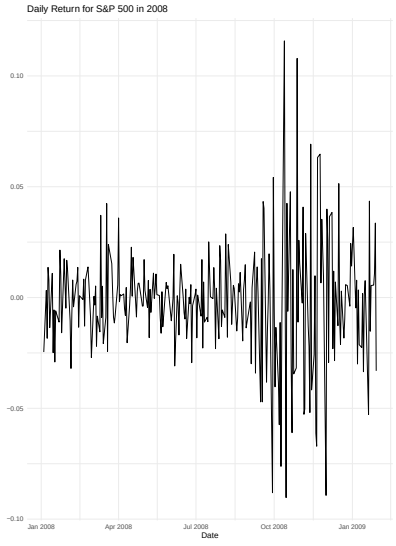
Differences are driven in part by differences in factors loadings

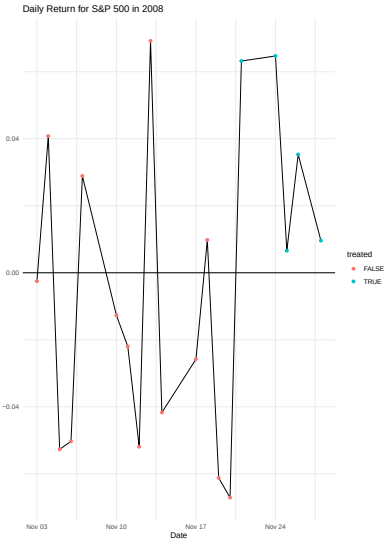
	Market		SMB		HML	
	Treated	Control	Treated	Control	Treated	Control
Original	1.2748	0.6592	0.2330	0.7484	0.6068	0.7196
SDID	1.2748	0.9051	0.2330	0.8187	0.6068	0.8724
SC	1.2748	1.1477	0.2330	0.4796	0.6068	0.7495

Balance better after using full sample

	Market		SMB		HML	
	Treated	Control	Treated	Control	Treated	Control
Original	1.2748	0.8569	0.2330	0.5526	0.6068	0.1436
SDID	1.2748	1.1654	0.2330	0.6273	0.6068	0.5934
SC	1.2748	1.2201	0.2330	0.3774	0.6068	0.6743

Factors mattered because of large volatility in the event





Conclusion

- Key takeaways:
  1. Rich set of applications in finance, potentially natural settings for synthetic methods
  2. Considering assignment mechanism for events is possibly important
- Financial setting falls into the standard model-based and design-based framework:
  - Use the same tools that have been developed in the econometrics literature to estimate the causal effect of events on asset returns
- Lots of good extensions to consider:
  - Continuous treatment effects
  - Time-varying models (Instrumented PCA, Kelly et al. (2017))