The Presource Curse

Anticipation, Disappointment, and Governance after Oil Discoveries

Erik Katovich

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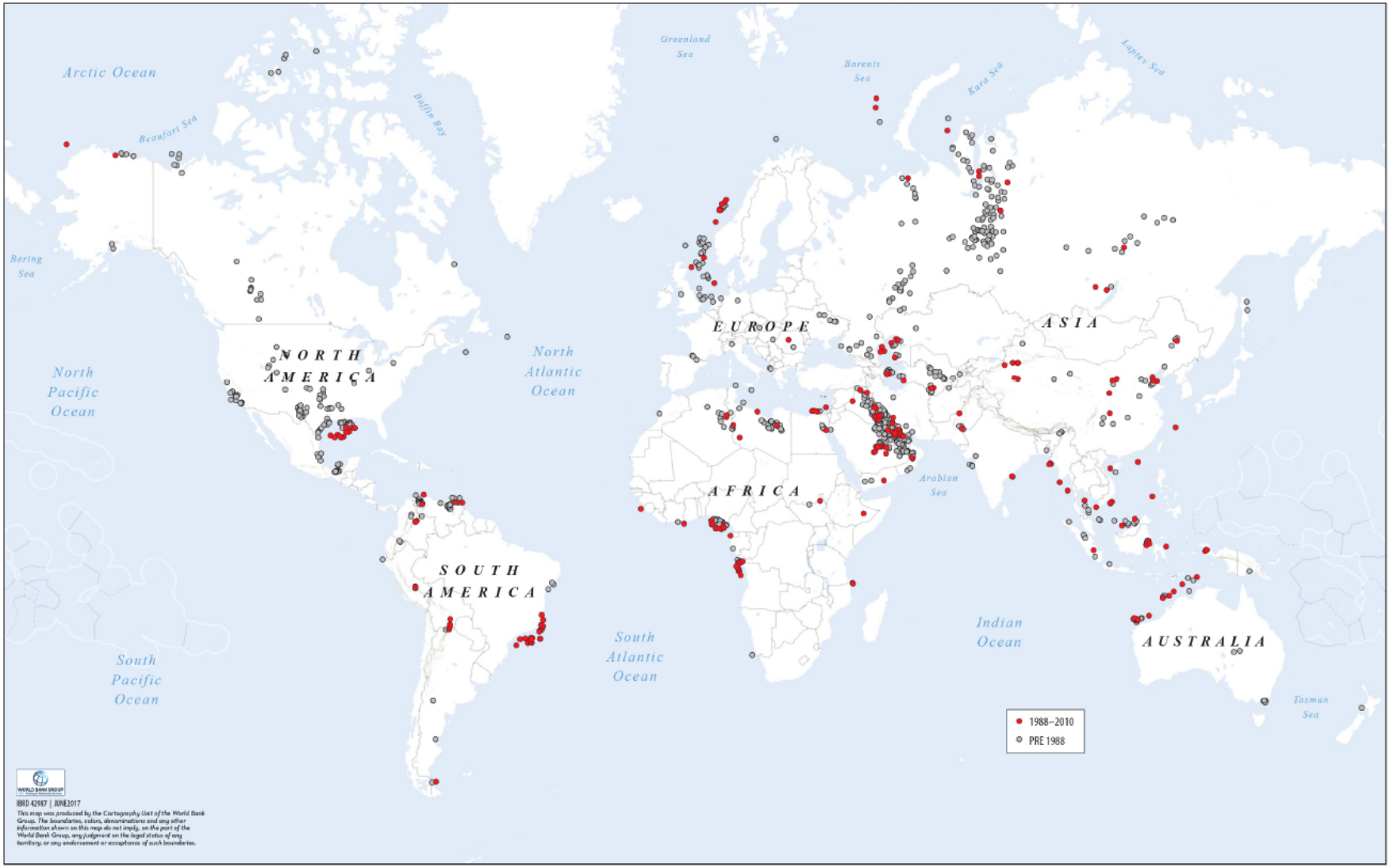
Overview of My Research Agenda

1. **Resource Discoveries and Revenue Sharing**
   - The Presource Curse? Anticipation, Disappointment, and Governance after Oil Discoveries (*Job Market Paper*)
2. **Resource Booms, Busts, and Energy Transitions**
   - Labor Reallocation, Human Capital Investment, and "Stranded Careers": Evidence from an Oil Boom and Bust (*with Dominic Parker and Steven Poelhekke*)
3. **Political Economy of Deforestation and Land Use**
   - Agricultural Elites, Special Interest Politics, and Deforestation: Property-Level Evidence from the Amazon (*with Fanny Moffette*)
4. **Firms, Industrial Policy, and Structural Transformation**
   - Can Natural Resources Promote Industrialization? Firms, Competition, and Spillovers from a Local Origin Policy (*funded by STEG-CEPR Grant*)
   - Creating Knowledge Economies: Innovative Firms and Skilled Workers After a Nation-Wide University Rollout (*with Ana Paula Melo*)

Giant Oil or Gas Discoveries Have Affected 46 Countries Since 1988



Discoveries $\geq$ 500 Million Barrels of Oil Equivalent, Cust and Mihalyi (2021)

Post-Discovery Uncertainty Creates Challenges for Governance

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> **Weapons purchases** (Vézina, 2020)

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Country-level variation in treatment by discoveries makes it difficult to explore detailed governance outcomes or establish causality

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- Exploit **quasi-experimental, subnational variation** in offshore discoveries and subsequent production realizations in Brazil

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- Harness municipality panel data to explore **dynamic governance outcomes** (public finances, public goods provision, electoral competition, patronage)

- Decompose discovery effects across two "treatment arms": places that ultimately receive windfalls ("**satisfied**") and places that don't ("**disappointed**")

  $\rightarrow$ **I show that each group confronts distinct but significant governance challenges**

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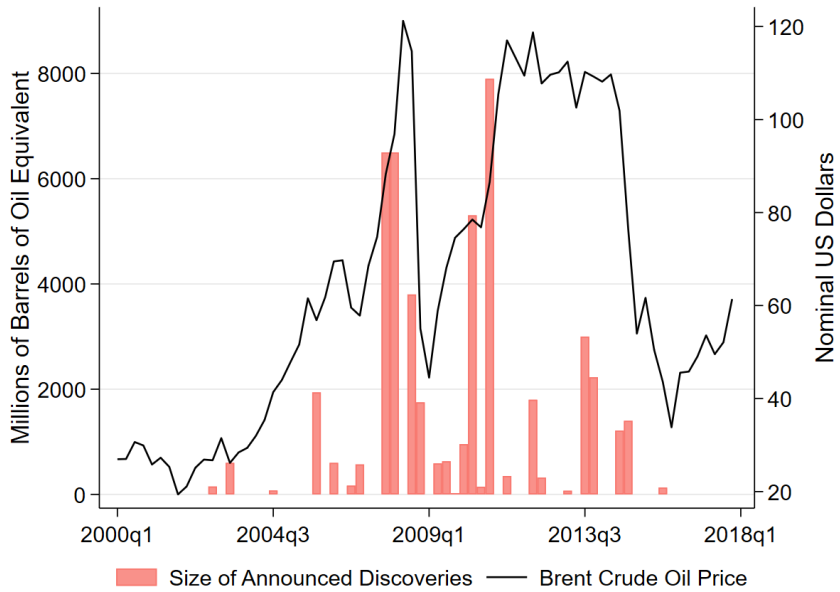
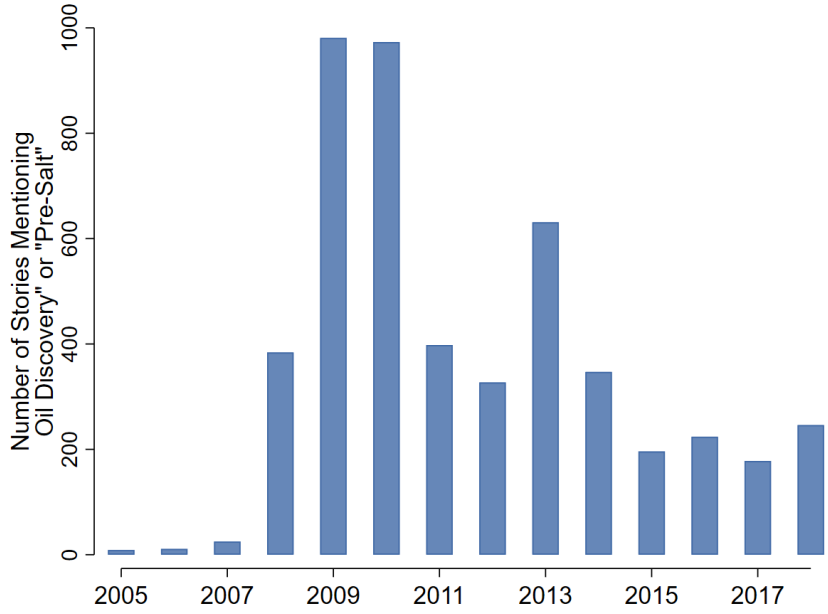
   In disappointed places, tax and transfer revenues $\downarrow$ and political turnover $\uparrow$; in both treatment arms, politician schooling $\downarrow$

Brazil's Pre-Salt Discoveries: A Winning Lottery Ticket?

Lula da Silva (2008): *"The Pre-Salt is a gift from God, a passport to the future, a winning lottery ticket, but could become a curse if we dont invest the money well."*

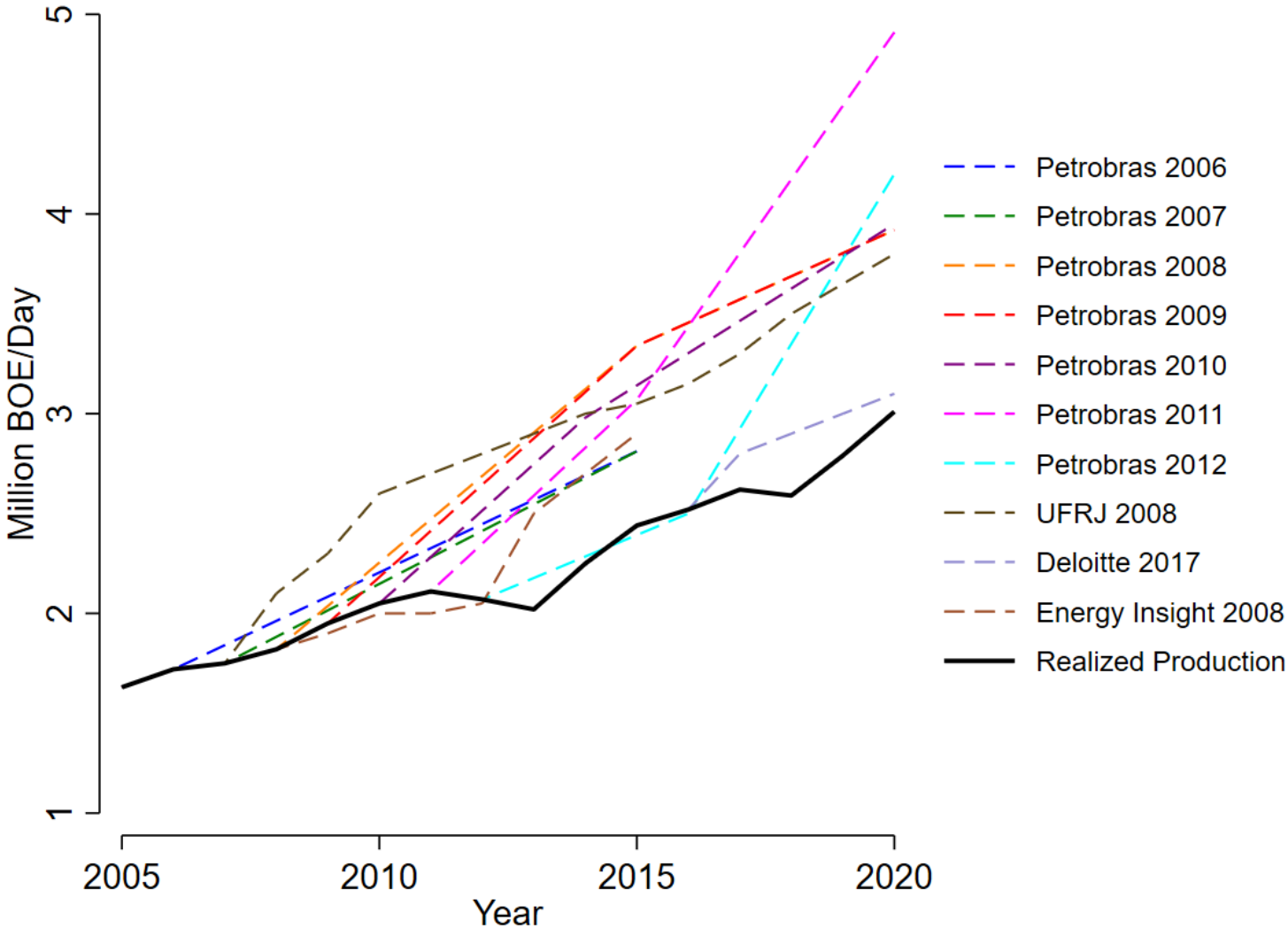


World Oil Prices and Oil Discoveries in Brazil



News Coverage of Oil Discoveries in *O Globo*

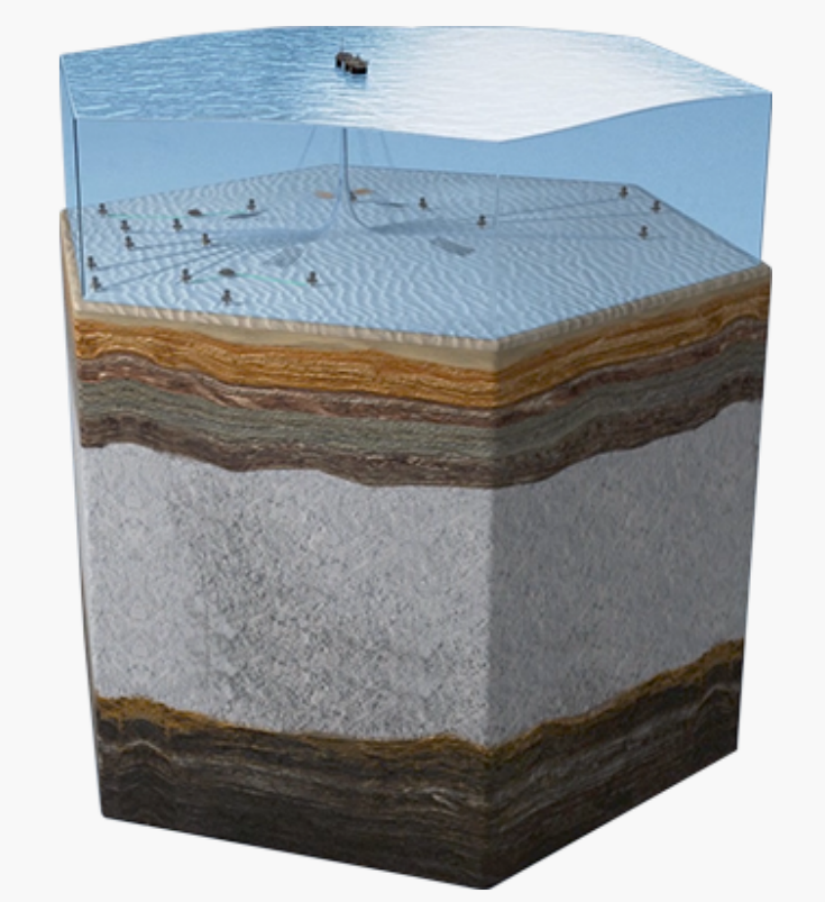
Brazil's Production Hasn't Met Expectations



Country-Level Production Forecasts vs Realized Production

Context: Why Are Offshore Oil Discoveries So Uncertain?

- **Geology:** Newly discovered reserves can turn out to be of lower quality or more difficult to extract than initially expected
- **Price Fluctuations:** A reserve that was commercially viable at \$80/barrel may no longer be viable at \$40/barrel, causing it to be abandoned
- **Producer Idiosyncracies:** Firms may exaggerate discovery potential, or fail to develop reserves due to financial difficulties or shifts in strategy



Floating Production Storage and Offloading Vessel Over Ultra-Deepwater Pre-Salt Deposits (Petrobras, 2021)

Exploiting a Quasi-Experiment I: Discovery Announcements

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Novo poço confirma potencial de petróleo leve em Tupi

Rio de Janeiro, 04 de junho de 2009 – PETRÓLEO BRASILEIRO S/A - PETROBRAS, [Bovespa: PETR3/PETR4, NYSE: PBR/PBRA, Latibex: XPBR/XPBRA, BCBA: APBR/APBRA], uma companhia brasileira de energia com atuação internacional, comunica que a perfuração de mais um poço na área de Tupi reforça as estimativas do potencial de 5 a 8 bilhões de barris de óleo leve e gás natural recuperável nos reservatórios do pré-sal daquela área, em águas ultraprofundas da Bacia de Santos. O poço ainda encontra-se em perfuração, na busca de objetivos mais profundos.

A uma distância de 33 km a noroeste do poço pioneiro 1-RJS-628, o novo poço, denominado 4-BRSA-711-RJS (4-RJS-647), confirmou a presença de reservatórios de boa qualidade e a presença de óleo semelhante ao poço pioneiro de Tupi, o que reforça as estimativas iniciais para a área.

Informalmente conhecido como Iracema, este terceiro poço está localizado na área do Plano de Avaliação de Tupi, em lâmina d'água de 2.210 metros, e a cerca de 250 km da costa do Rio de Janeiro.

A descoberta foi comprovada através de amostragens de petróleo leve (cerca de 30º API) por teste a cabo, em reservatórios localizados em profundidade de cerca de 5.000 metros, e comunicada à Agência Nacional do Petróleo, Gás Natural e Biocombustíveis - ANP nesta data.

Após a conclusão da perfuração, o Consórcio, formado pela Petrobras (65% - Operadora), BG Group (25%) e Galp (10%), para a exploração do bloco BM-S-11, onde fica a área de Tupi, dará continuidade às atividades e investimentos previstos no Plano de Avaliação aprovado pela ANP e que prevê a perfuração de outros poços na área.

"Communication to the Market" Filed by Petrobras with *Comissão de Valores Mobiliários*

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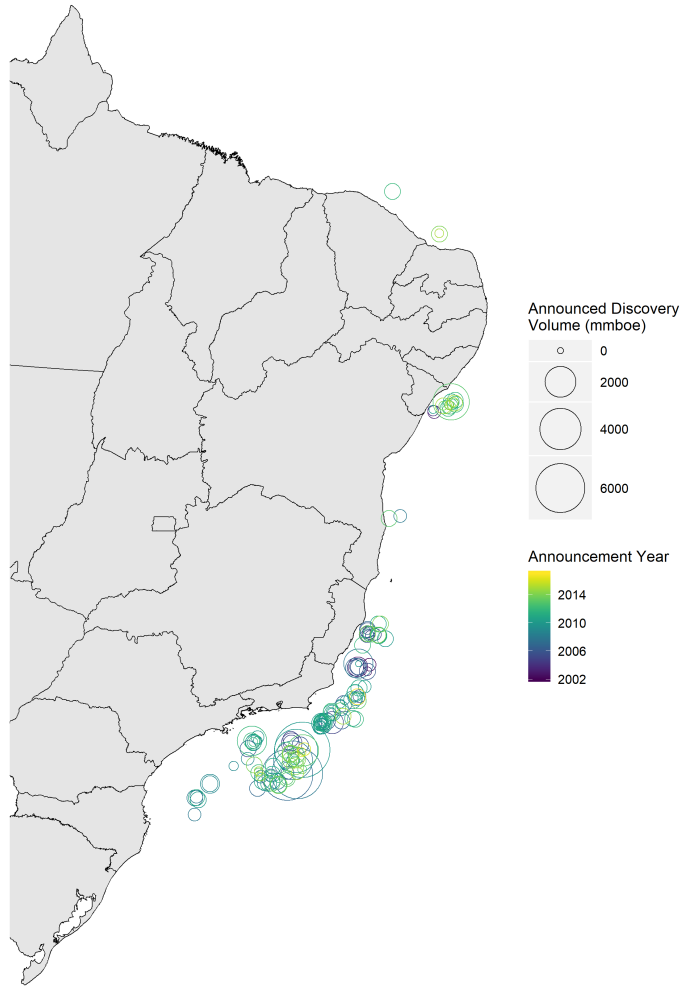
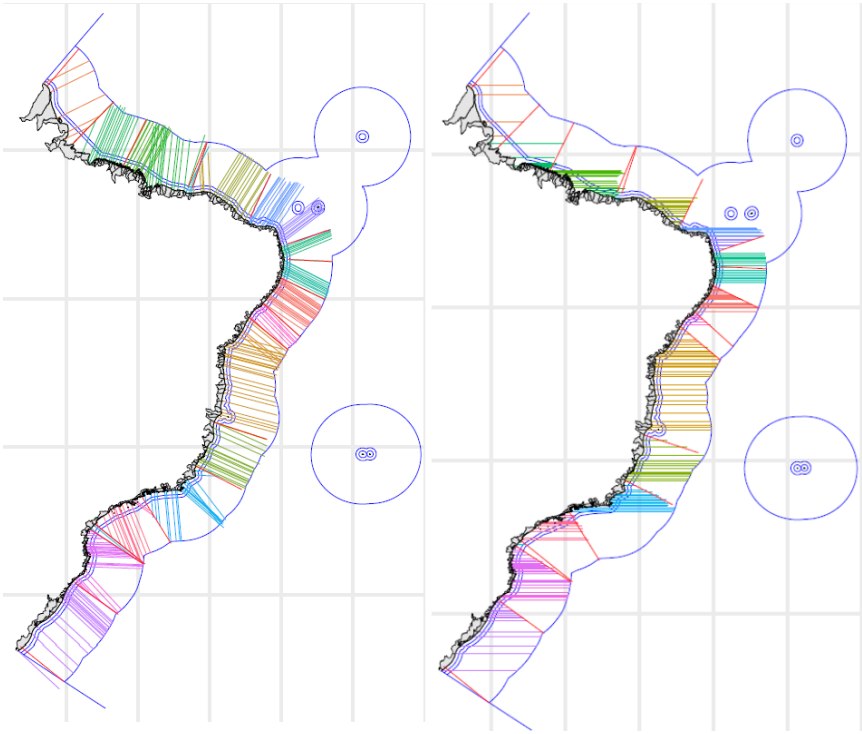


Exploiting a Quasi-Experiment II: Royalty Distribution Maps

Next, I recreate geodesic projections of coastal boundaries used by Brazilian government to allocate offshore royalties to coastal municipalities



Orthogonal (Left) and Parallel (Right)
Projections of Coastal Municipal Boundaries

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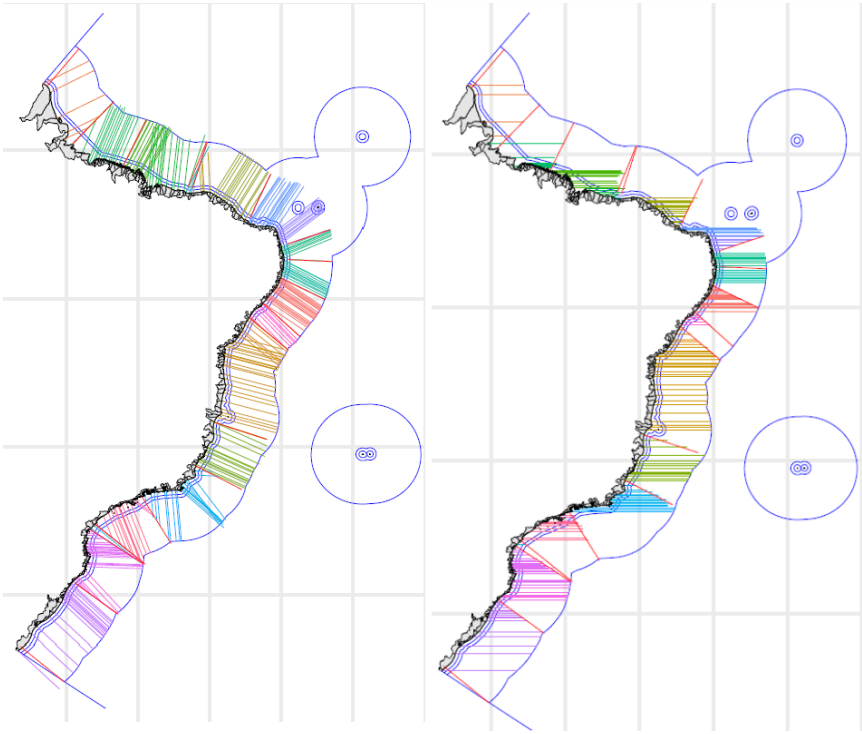

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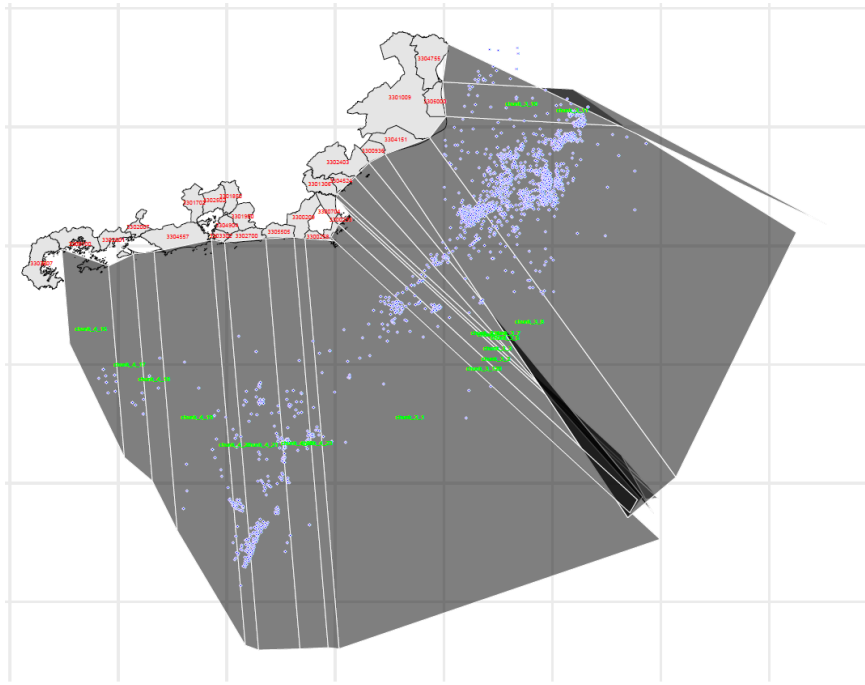
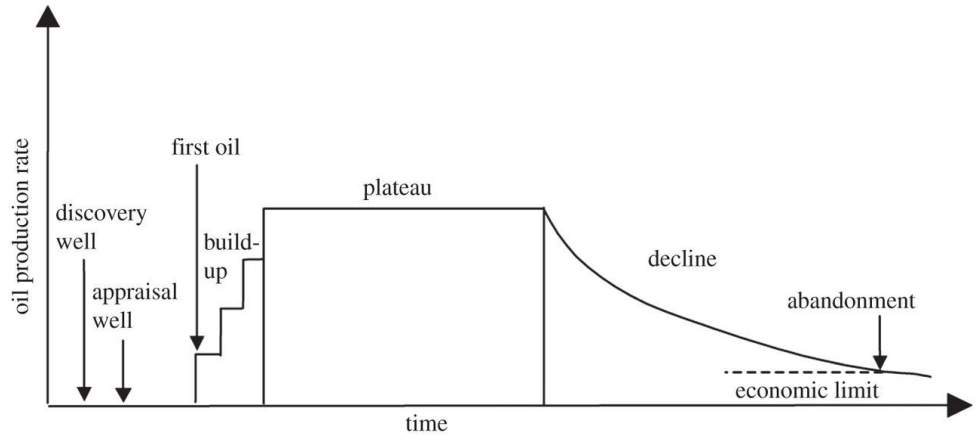


Offshore Wells Overlaid on Orthogonal Projections (Example: Rio de Janeiro)

Exploiting a Quasi-Experiment III: Forecasting Revenue Expectations



Standard Offshore Production Timeline

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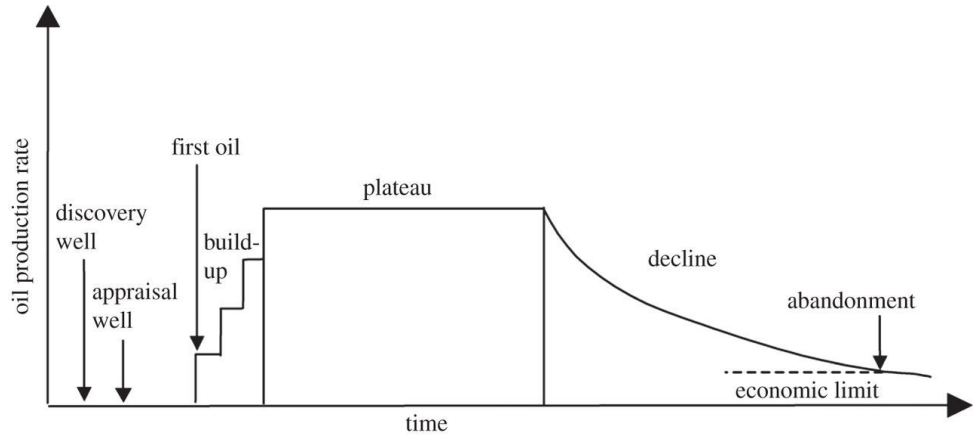

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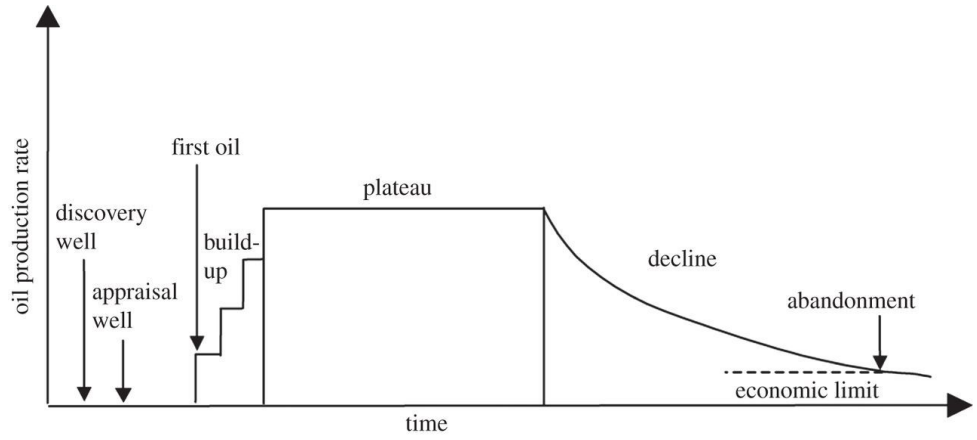

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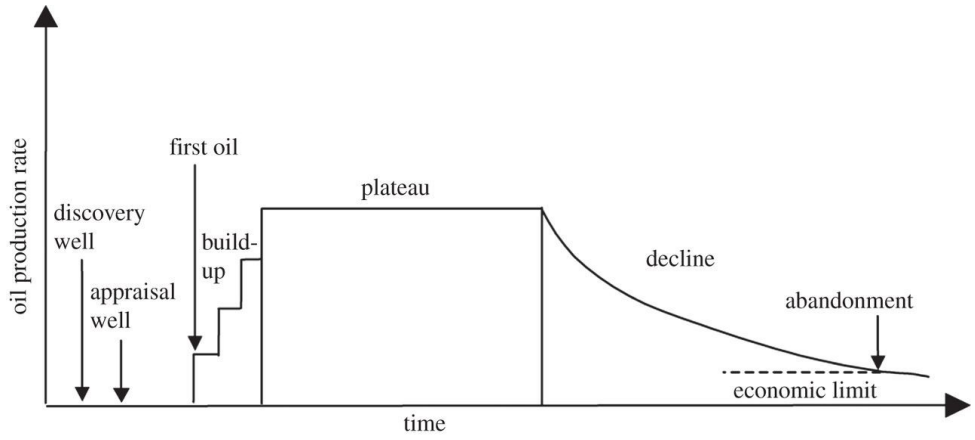


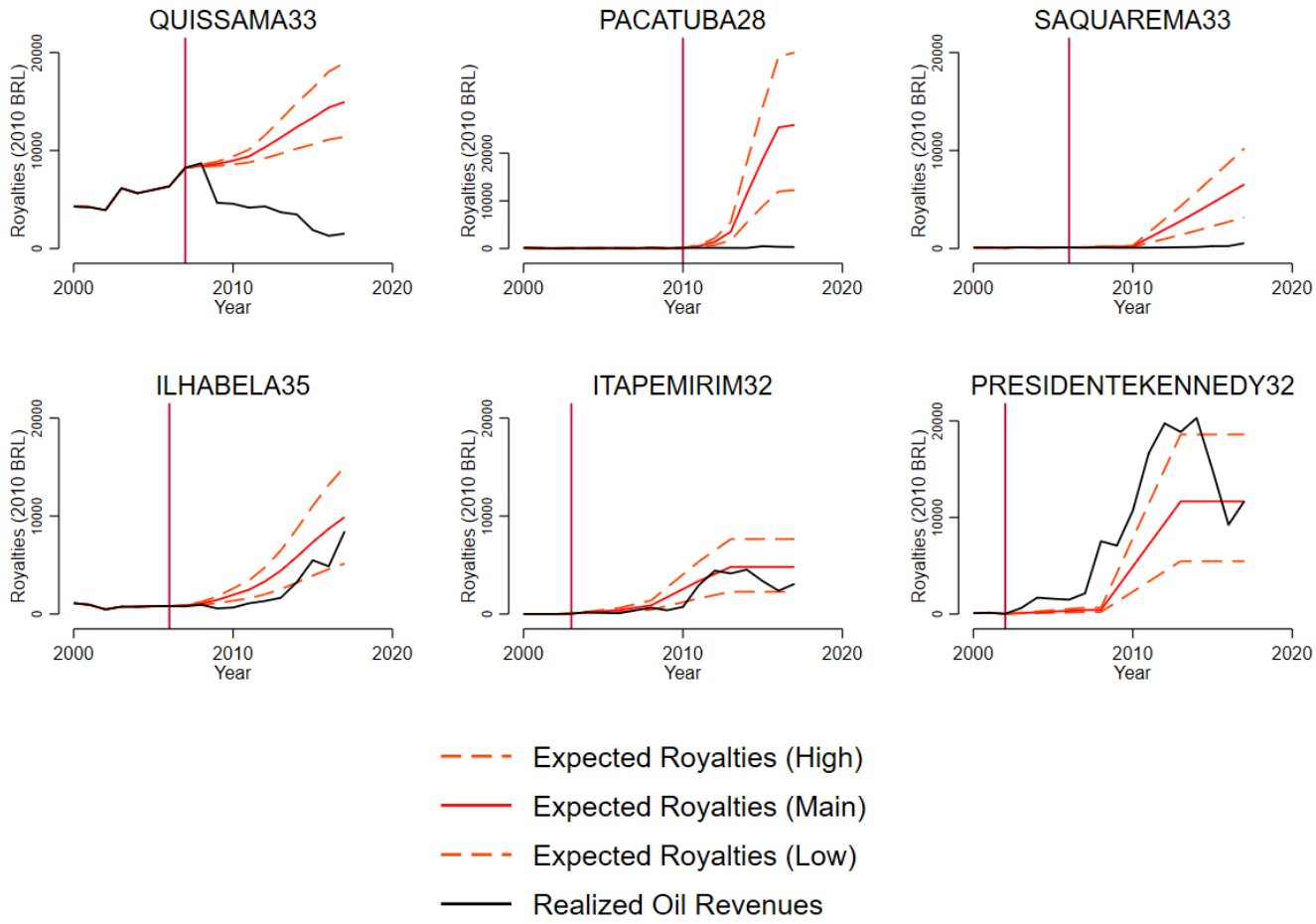
Standard Offshore Production Timeline

1. Forecast expected production stream after discovery announcement (function of volume discovered, average production delay, and standard offshore production assumptions)
2. Apply royalty distribution rules to forecast revenue stream
3. Compute forecast error for municipality m in year t:

$$Error_{mt} = \frac{\frac{Royalties_{mt}}{Royalties_{m,t0}}}{\frac{E(Royalties_{mt})}{Royalties_{m,t0}}} = \frac{\text{Realized Growth in Royalties since Discovery}}{\text{Expected Growth in Royalties since Discovery}}$$

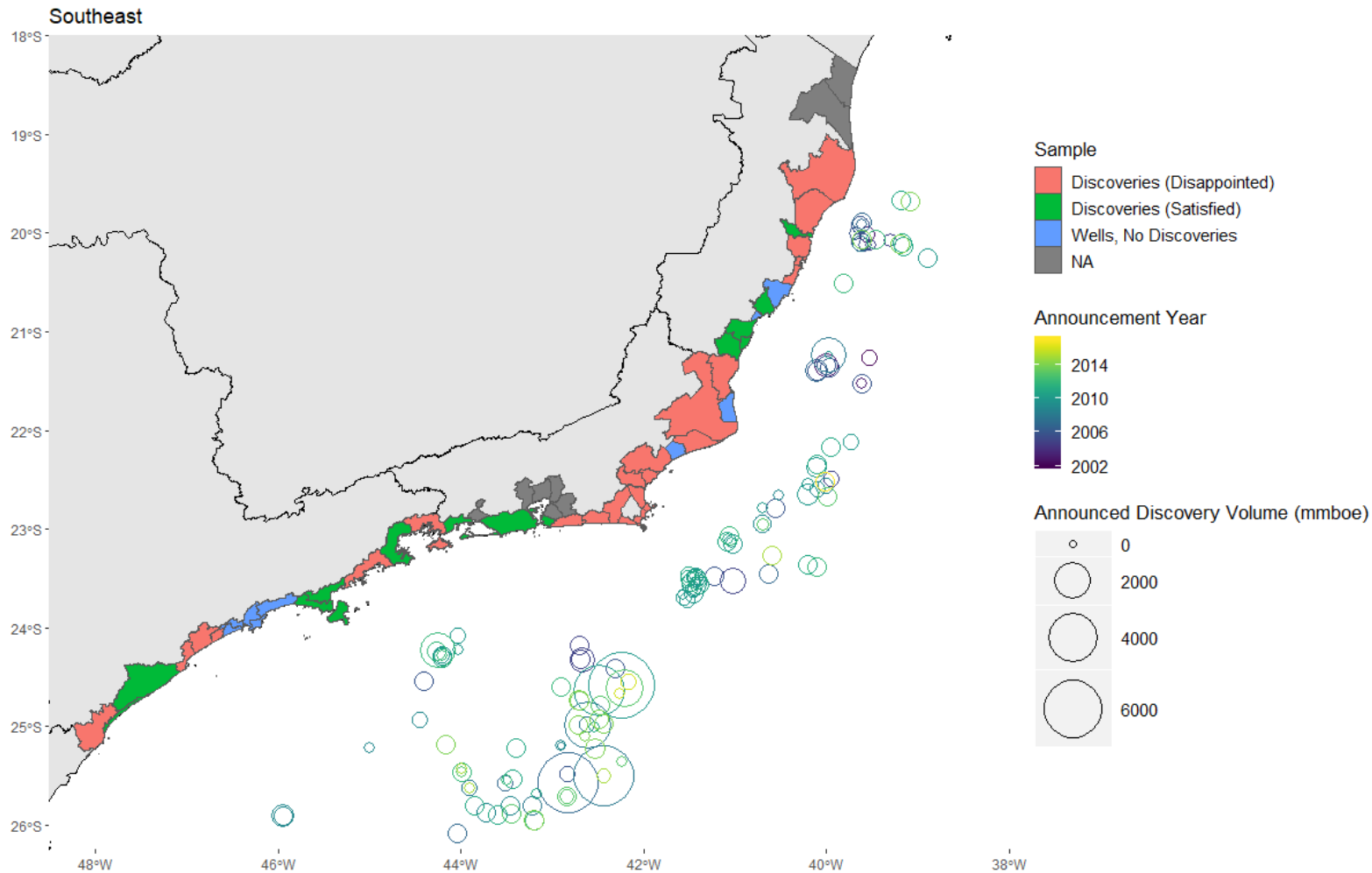
▸ Forecasting Model

Comparing Forecast vs. Realized Revenues (Selected Examples)



- Of 48 municipalities affected by oil discoveries between 2000-2017, only 18 realize even 50% of the revenues they could have expected by 2017
  - Distributions of Forecast Error

Mapping Discovery Realizations (Example: Southeast Brazil)



▸ Full Brazilian Coastline ▸ Conditional Random Assignment Tests

Data Sources: Constructing a Rich Municipality-Level Panel

Data	Source	Years
Discovery Announcements	CVM	2002-2017
Oil Royalties & Special Participations	ANP	1999-2017
Offshore Well Shapefiles	ANP	2000-2017
Oil and Gas Production	ANP	2005-2017
Public Finances	FINBRA & IPEA	2000-2017
Employment & Firm Entry	RAIS	2000-2017
Federal and State Transfers	Tesouro Nacional	2000-2017
Elections (Candidates and Donors)	TSE	2000-2016
Health Indicators	SUS	2000-2017
Education Indicators	Basic Ed Census	2000-2017
Education Outcomes	IDEB	2005-2017
Municipal Development Index	FIRJAN	2000, 2005-2016
Municipality Characteristics	Census	2000, 2010
Brent Crude Oil Prices	FRED	2000-2017
Currency Deflator	IPEA (INPC)	2000-2017
Interest Rate	IPEA (Selic)	2000-2017

▸ Balance Across Samples

Event Study around First Discovery Announcement

- Let E_m be period when municipality m is "treated" with event (i.e. first discovery announcement). Let $K_{mt} = t - E_m$
- y_{mt} includes municipal governance outcomes (e.g., spending, revenue, debt, public goods provision)

$$y_{mt} = \delta_m + \lambda_t + \sum_{k \neq -1} \mathbb{1}(K_{mt} = k)\beta_k + \epsilon_{mt}$$

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  2. Callaway and Sant'Anna (2020) staggered event study estimator (CS)

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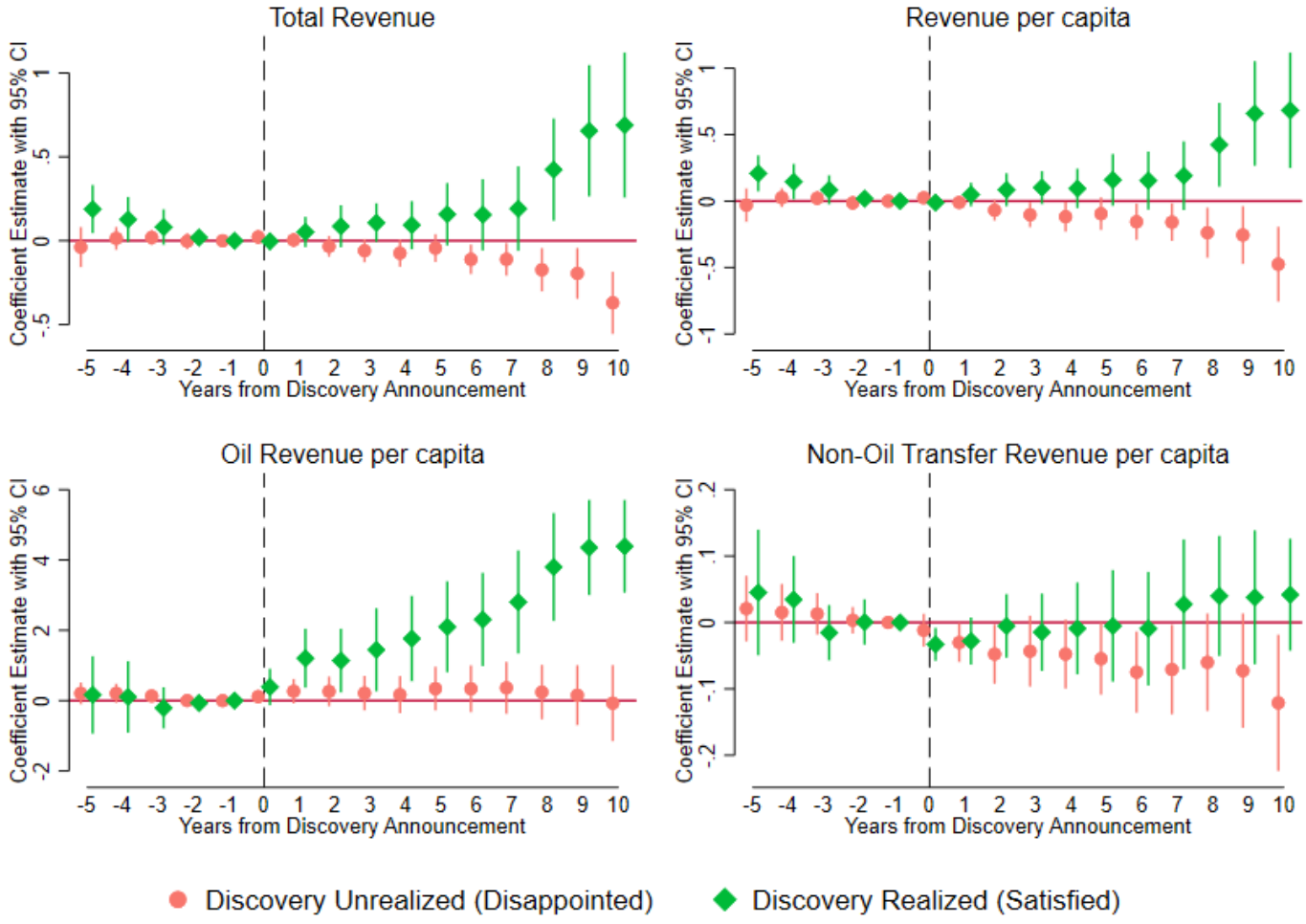
- **Are pre-trends parallel between treated and control groups?**
  - > Verify pre-trends in event studies ($\beta_k = 0$ for $t < -1$?)
  - > Examine pre-trends directly in sample means: ▸ Pre-Trends

▸ Panel Balance Across Relative Time Indicators

Results: Municipal Revenues after Oil Discoveries



Effects on Disappointed and Satisfied treated groups are estimated separately relative to never-treated controls (municipalities that had offshore exploratory wells but no discoveries). Continuous outcomes use inverse hyperbolic sine, standard errors are clustered at municipality level, monetary values are deflated to constant 2010 BRL, and 95% confidence intervals are reported. Revenues refer to realized, rather than budgeted values.

▸ Breakdown of Transfers ▸ Interpreting Coefficients

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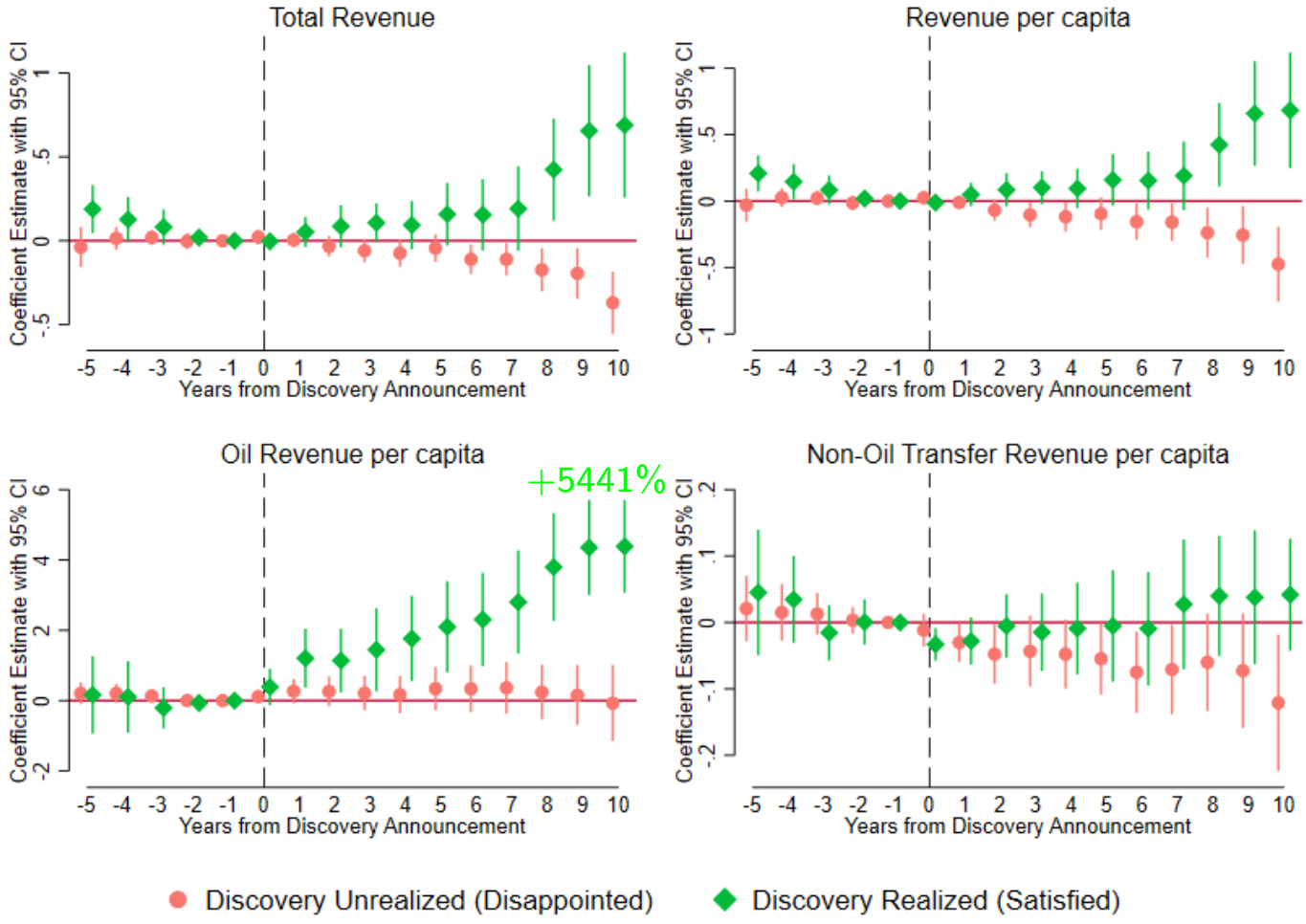

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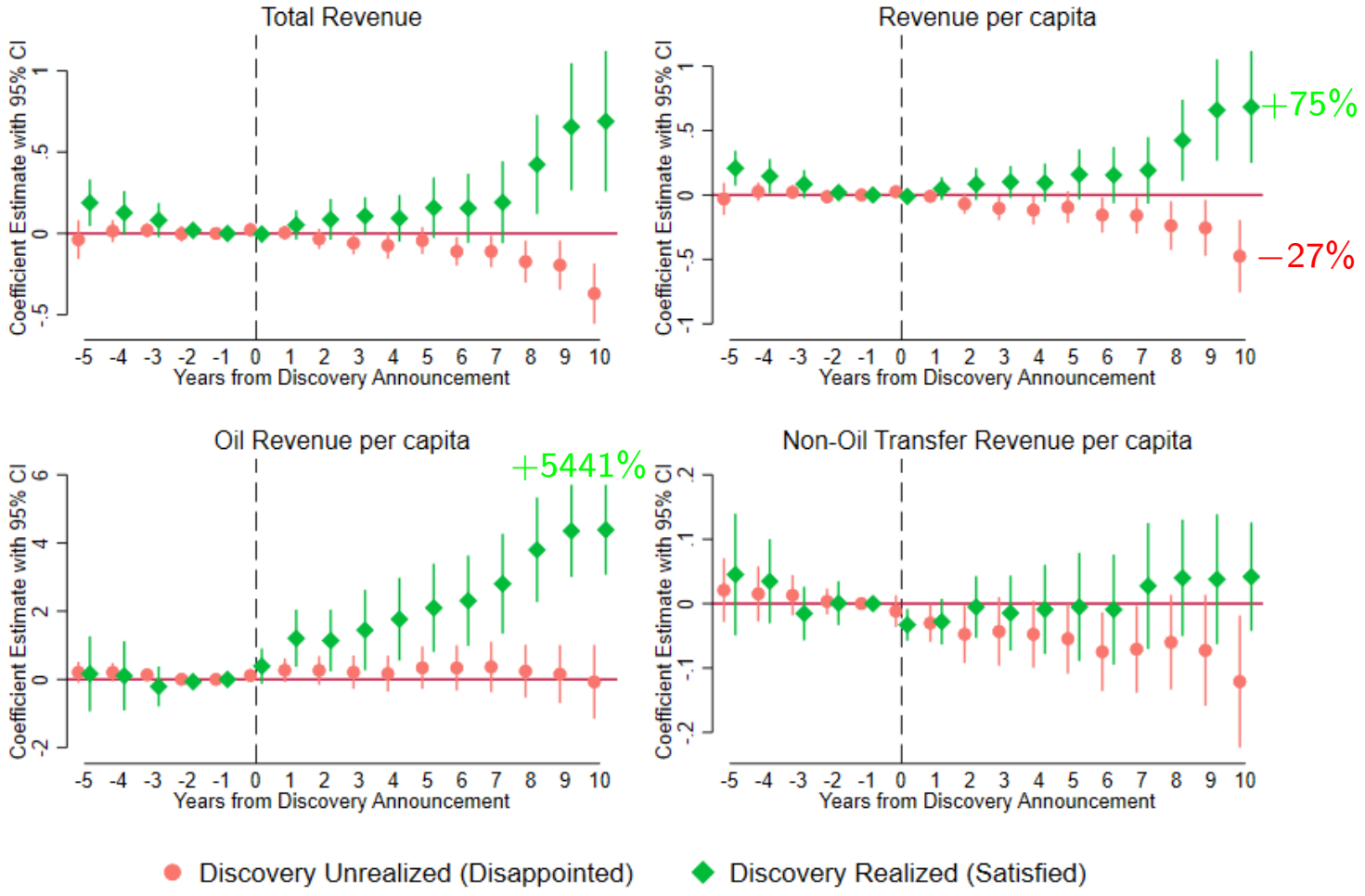

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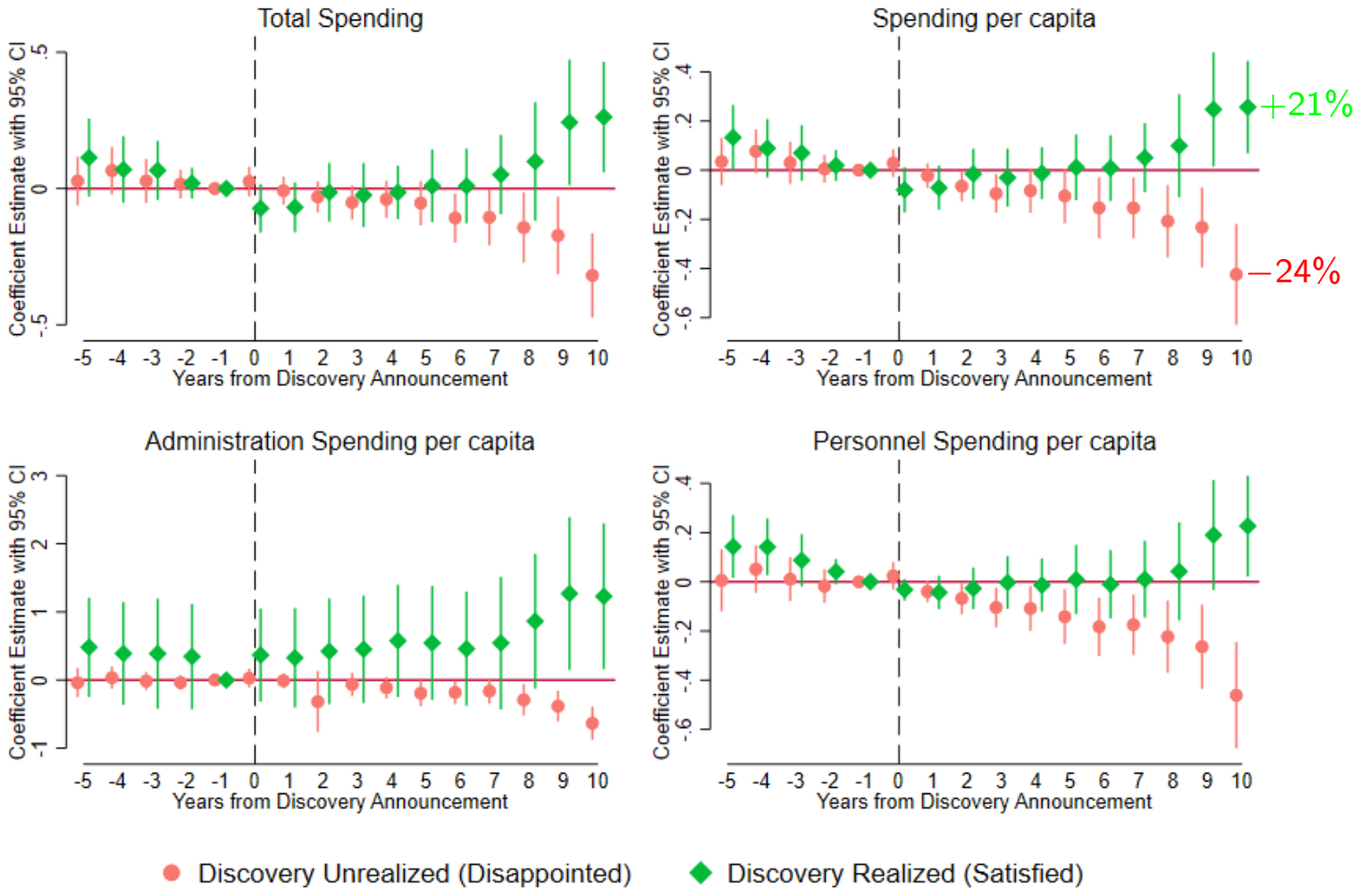
▸ Breakdown of Transfers ▸ Interpreting Coefficients

Results: Municipal Spending



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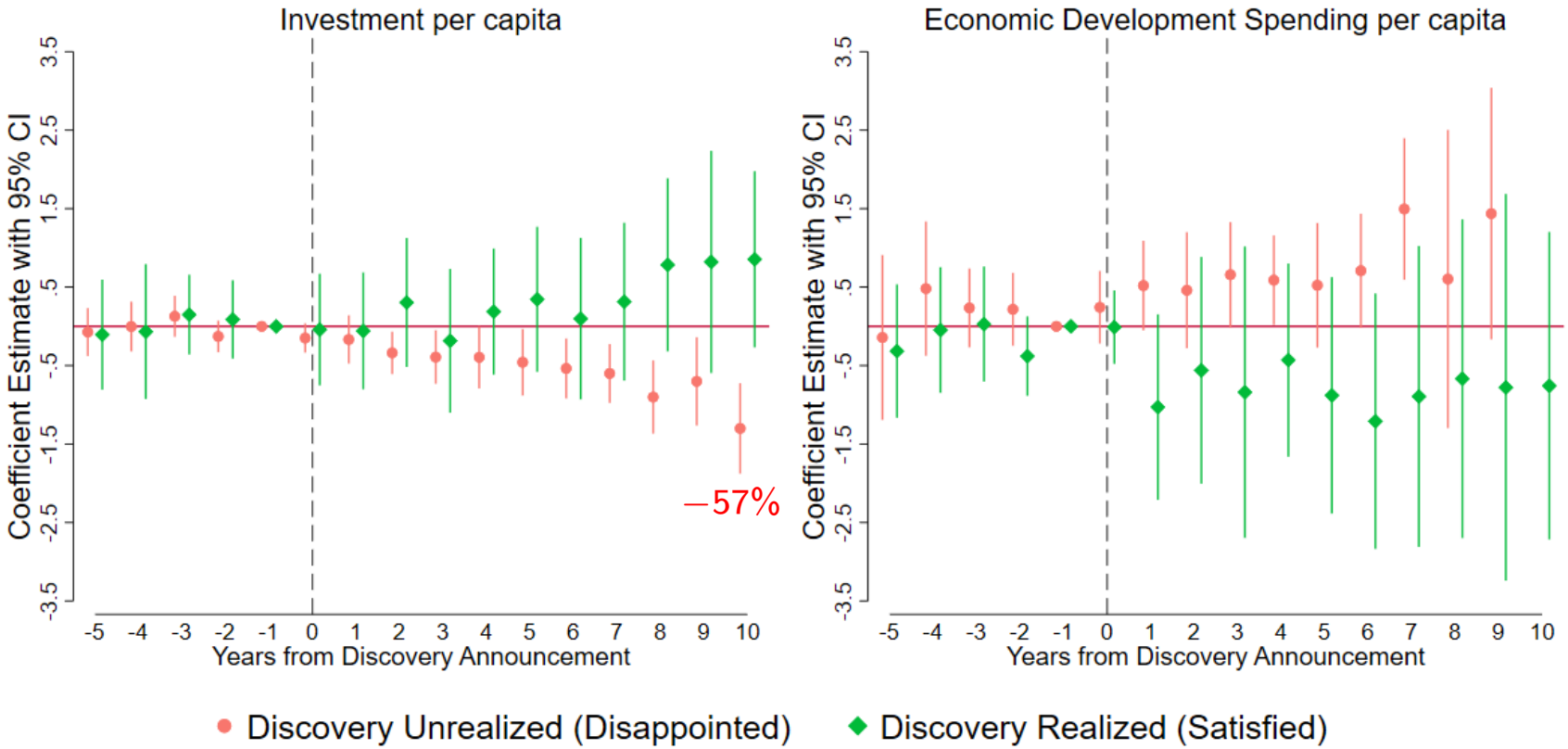
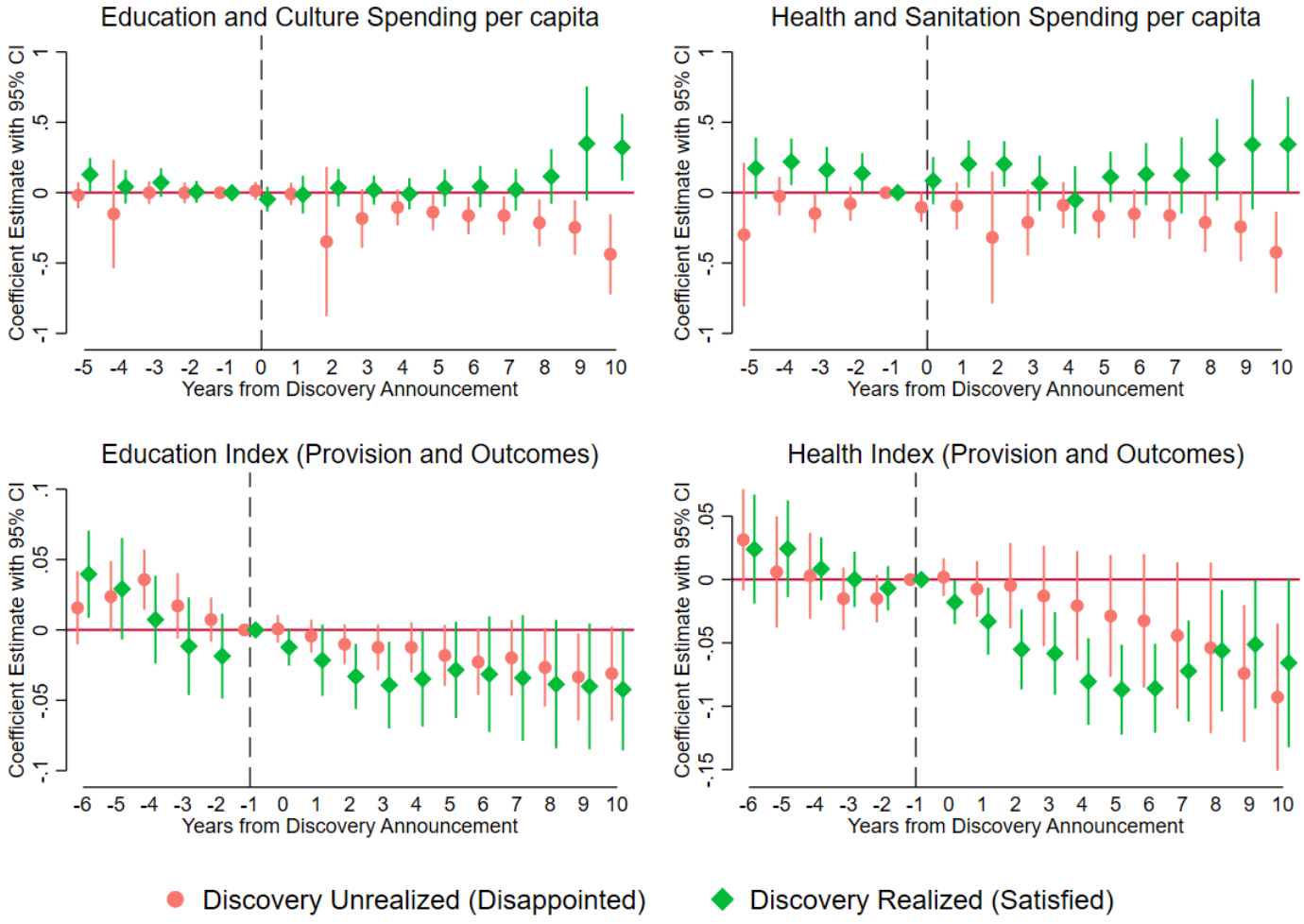
Results: Investment and Economic Diversification



Effects on Disappointed and Satisfied treated groups are estimated separately relative to never-treated controls (municipalities that had offshore exploratory wells but no discoveries). Continuous outcomes use inverse hyperbolic sine, standard errors are clustered at municipality level, monetary values are deflated to constant 2010 BRL, and 95% confidence intervals are reported. Investment refers to public municipal investment (e.g., infrastructure). Economic development spending refers to the sum of spending on promotion of agriculture, industry, and services.

Results: Public Goods Spending and Outcomes



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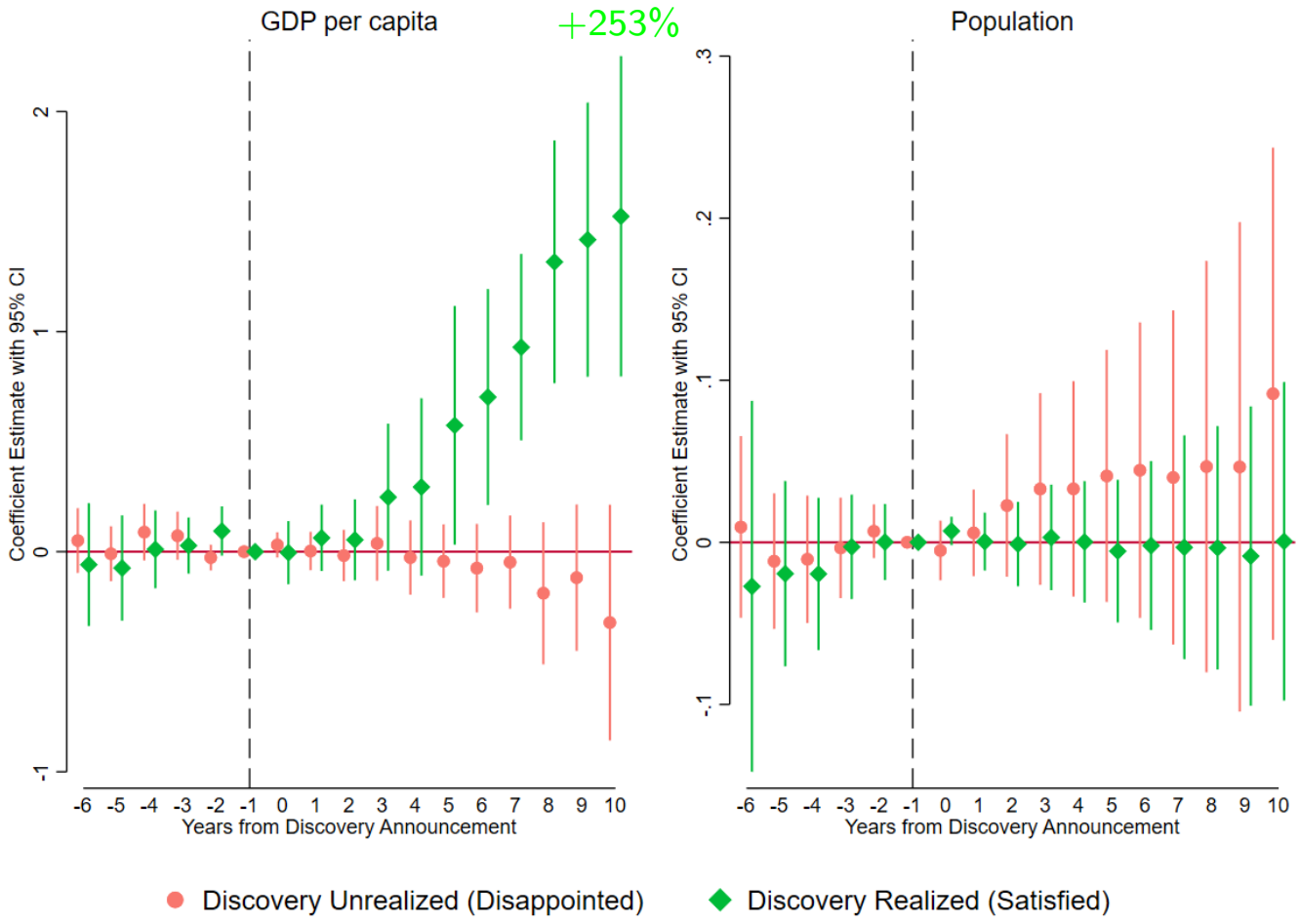
▸ Public Goods Provision and Quality

Results: Municipal GDP and Population



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▸ Results: In-Migration up to 2010 ▸ Interpreting Coefficients

Robustness Across Samples and Estimators (Disappointed Municipalities)

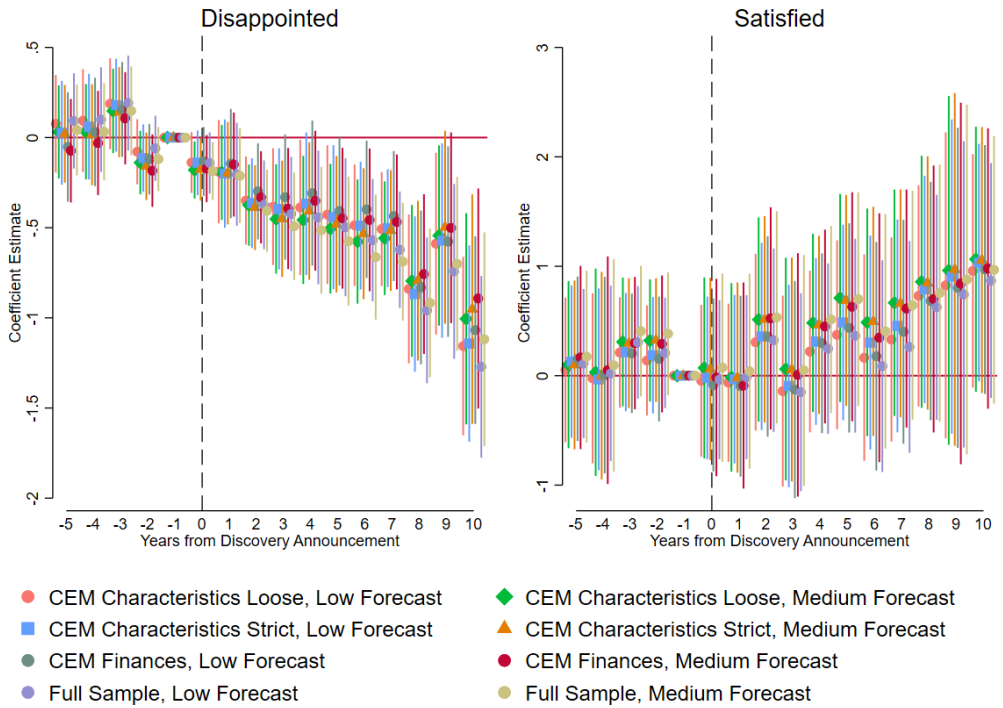
	TWFE Wells	TWFE Pre-Matching	CS Wells	CS Pre-Matching
Revenue p.c.	-0.26**	-0.23**	-0.54***	-0.37**
	(0.11)	(0.10)	(0.17)	0.19
Tax Revenue p.c.	-0.35	-0.34*	-0.26	-0.30
	(0.23)	(0.18)	(0.29)	0.24
Oil Revenue p.c.	0.16	0.50	-0.03	0.16
	(0.43)	(0.39)	(0.72)	0.69
Transfer Revenue p.c.	-0.07*	-0.06*	-0.14**	-0.15***
	(0.04)	(0.04)	(0.07)	0.06
Spending p.c.	-0.23***	-0.14*	-0.46***	-0.25*
	(0.08)	(0.07)	(0.12)	0.14
Investment p.c.	-0.70**	-0.80***	-1.28***	-1.04***
	(0.28)	(0.26)	(0.33)	0.37
Personnel Spending p.c.	-0.26***	-0.16**	-0.52***	-0.29*
	(0.09)	(0.08)	(0.14)	0.15
Education Spending p.c.	-0.25**	-0.19**	-0.46***	-0.32**
	(0.10)	(0.09)	(0.16)	0.14
Health Spending p.c.	-0.24*	-0.33***	-0.43***	-0.33
	(0.12)	(0.11)	(0.15)	0.20
n (municipality-years)	1,494	15,570	1,494	15,570

Each column reports coefficient estimates and standard errors for the t + 10 period of event studies for a specific control group-estimator pair. *** p<0.01, ** p<0.05, * p<0.1 ▸ Satisfied Municipalities ▸ Callaway and Sant'Anna Event Studies

Further Robustness Checks

- Alternative forecasting and matching parameters ▸ Sensitivity Analysis

Selected Example: Investment



- Event studies with multiple events ▸ Multiple Events
- Spatial spillovers onto neighboring municipalities ▸ Spatial Spillovers

Mechanism I: Electoral Reaction to Discoveries

- Municipality m was treated in 4 years prior to election e ($T_{me} = 1$) if it experienced a discovery during that period
- y_{me} measures electoral competition, fundraising, candidate and winner characteristics, and patronage

$$y_{me} = \delta_m + \lambda_e + \beta_1 T_{me} + \epsilon_{me}$$

	TWFE Wells	TWFE Pre-Match	CS Wells	CS Pre-Match
Competitive Candidates/Seat	0.047**	0.038**	0.068***	0.033
	(0.019)	(0.018)	(0.025)	(0.022)
Total Number of Donations	0.169*	0.149	0.157*	0.164**
	(0.087)	(0.091)	(0.092)	(0.069)
Total Value of Donations	0.131*	0.119	0.238**	0.114
	(0.078)	(0.083)	(0.120)	(0.113)
Avg. Candidate Schooling	-0.030***	-0.024***	-0.031**	-0.009
	(0.009)	(0.006)	(0.014)	(0.010)
Municipality FEs	Y	Y	Y	Y
Election FEs	Y	Y	Y	Y
n (municipality-elections)	404	3,745	404	3,745

Each column reports coefficient estimates and standard errors for different combinations of estimator (TWFE and Callaway and Sant'Anna (CS)) and control group (Wells and Pre-Matched). Monetary values are deflated to constant 2010 BRL. Continuous variables are transformed using inverse hyperbolic sine transformation. Standard errors are clustered at the municipality level. *** p<0.01, ** p<0.05, * p<0.1

▸ Patronage and Elected Politician Characteristics

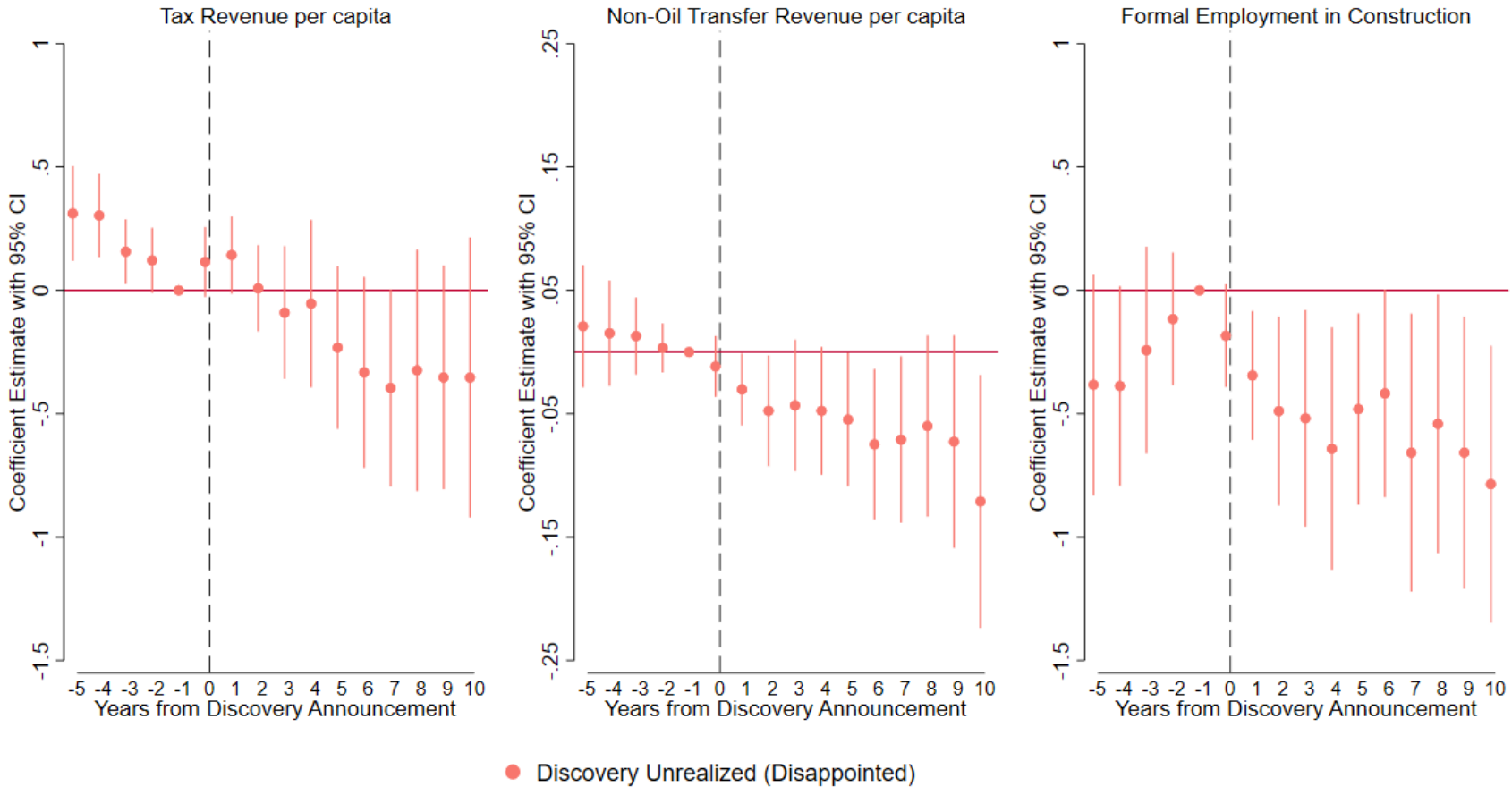
Mechanism II: Political Turnover After Disappointment

$$P(Reelection_{cme} = 1) = \delta_m + \lambda_e + \beta Disappointed_{me} + X'_{cme}\mu + \epsilon_{cme}$$

	Disappointed		Satisfied	
	LPM	Logit	LPM	Logit
Mayor	-0.119*	-0.136	-0.006	-0.006
	(0.070)	(0.089)	(0.034)	(0.034)
n (candidate-election periods)	10,815	10,815	10,850	10,850
Council	-0.052***	-0.042***	-0.005	-0.008
	(0.017)	(0.016)	(0.009)	(0.010)
n (candidate-elections)	160,169	160,169	160,945	160,945

Table reports coefficient estimates (marginal effects for logit models) with standard errors clustered at municipality level in parentheses $Disappointed_{me}$ is same indicator used in event study analyses, but time-varying. Election and municipality fixed effects are included, as well as candidate-level controls (age, sex, and education level). *** p<0.01, ** p<0.05, * p<0.1

Mechanism III: Taxes, Transfers, and Private Sector Response



Effects on Disappointed municipalities are estimated relative to never-treated controls (municipalities that had offshore exploratory wells but no discoveries). Continuous outcomes use inverse hyperbolic sine, standard errors are clustered at municipality level, monetary values are deflated to constant 2010 BRL, and 95% confidence intervals are reported.

▸ Breakdown of Transfers

Summing Up Main Findings

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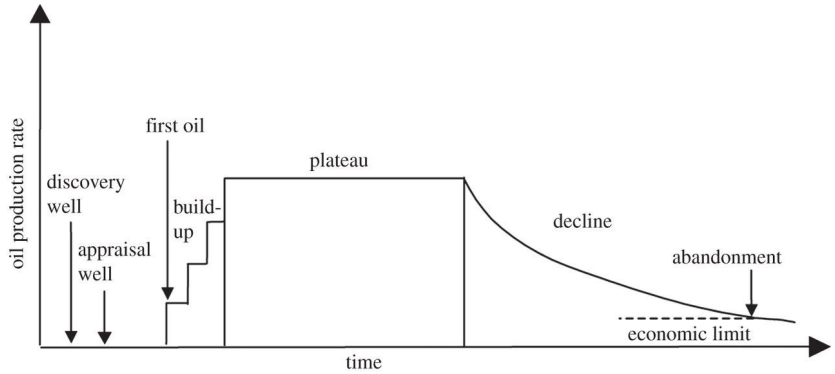
- **Mechanisms:** Political reaction to discovery announcements may increase rent-seeking; disappointed places experience political turnover and private sector outflows

Policy: Concentrating resource revenues in specific places exacerbates uncertainty

→ Spreading risk across exploration portfolio would smooth idiosyncratic outcomes, dilute disappointment, and avoid overwhelming administrative capacity

Forecasting Municipalities' Discovery Expectations I



Standard Offshore Production Timeline

Municipality m's **expected production stream** from discovery d in year t:

$$E(Production_{mdt}) = \begin{cases} 1(alignment_{md} = 1) \times \delta V_d \times \frac{(t - t_0)}{\theta_{st}} & \text{if} \quad t - t_0 \leq \theta_{st} \\ 1(alignment_{md} = 1) \times \delta V_d & \text{if} \quad t - t_0 > \theta_{st} \end{cases}$$

- t_0 is year of discovery announcement
- V_d is volume of the announced discovery
- δ is proportion of total reserve extracted each year (US EIA, 2015)
- θ_{st} is average discovery-to-production delay in sedimentary basin s up to year t

Value of royalties associated with expected production:

$$E(Royalties_{mdt}) = \underbrace{\left(1(alignment_{mw} = 1) \times E(Prod_{mdt}) \times (P_{t0} \times X_{t0}) \times 0.30 \times 0.05\right)}_{\text{First 5\% of Royalty Tax to Municipalities Aligned with Well}} + \underbrace{\left(E(Prod_{mdt}) \times (P_{t0} \times X_{t0}) \times 0.225 \times (R_f - 0.05) \times A_{mf}\right)}_{\text{Tax in Excess of 5\% to Municipalities Aligned with Field}}$$

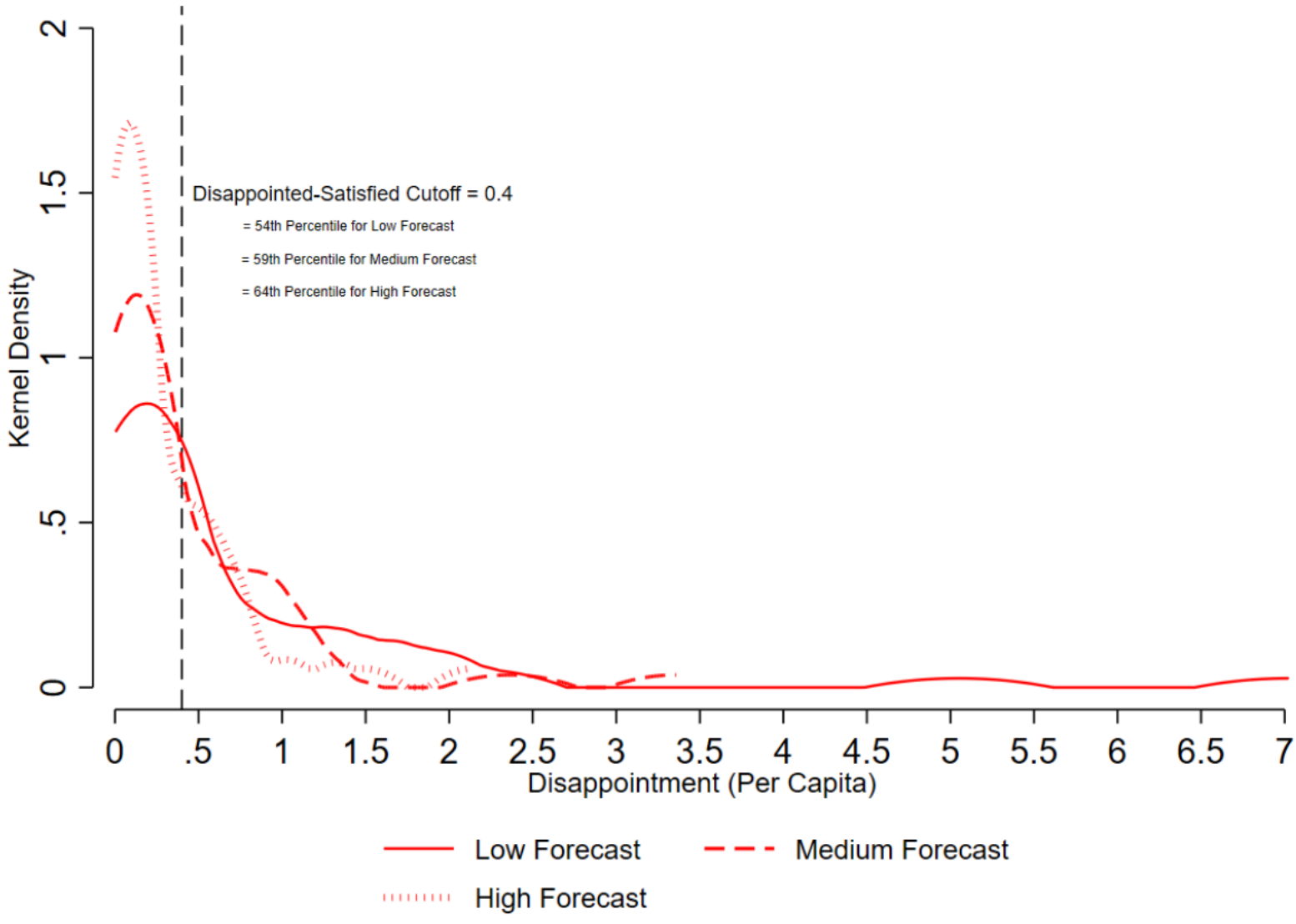
- P_{t0} and X_{t0} are world oil price and BRL/USD exchange rate in year of discovery
- A_{mf} is m's share of alignment with field f
- R_f is field-specific tax rate

In each period, compute **error** in municipality m in year t:

$$Error_{mt} = \frac{\frac{Royalties_{mt}}{Royalties_{m,t0}}}{\frac{E(Royalties_{mt})}{Royalties_{m,t0}}}$$

This is the ratio of realized royalty growth between discovery announcement in $t0$ and current period t, and expected royalty growth over the same period. ▸ Return

Distributions of Forecast Error Across Treated Municipalities



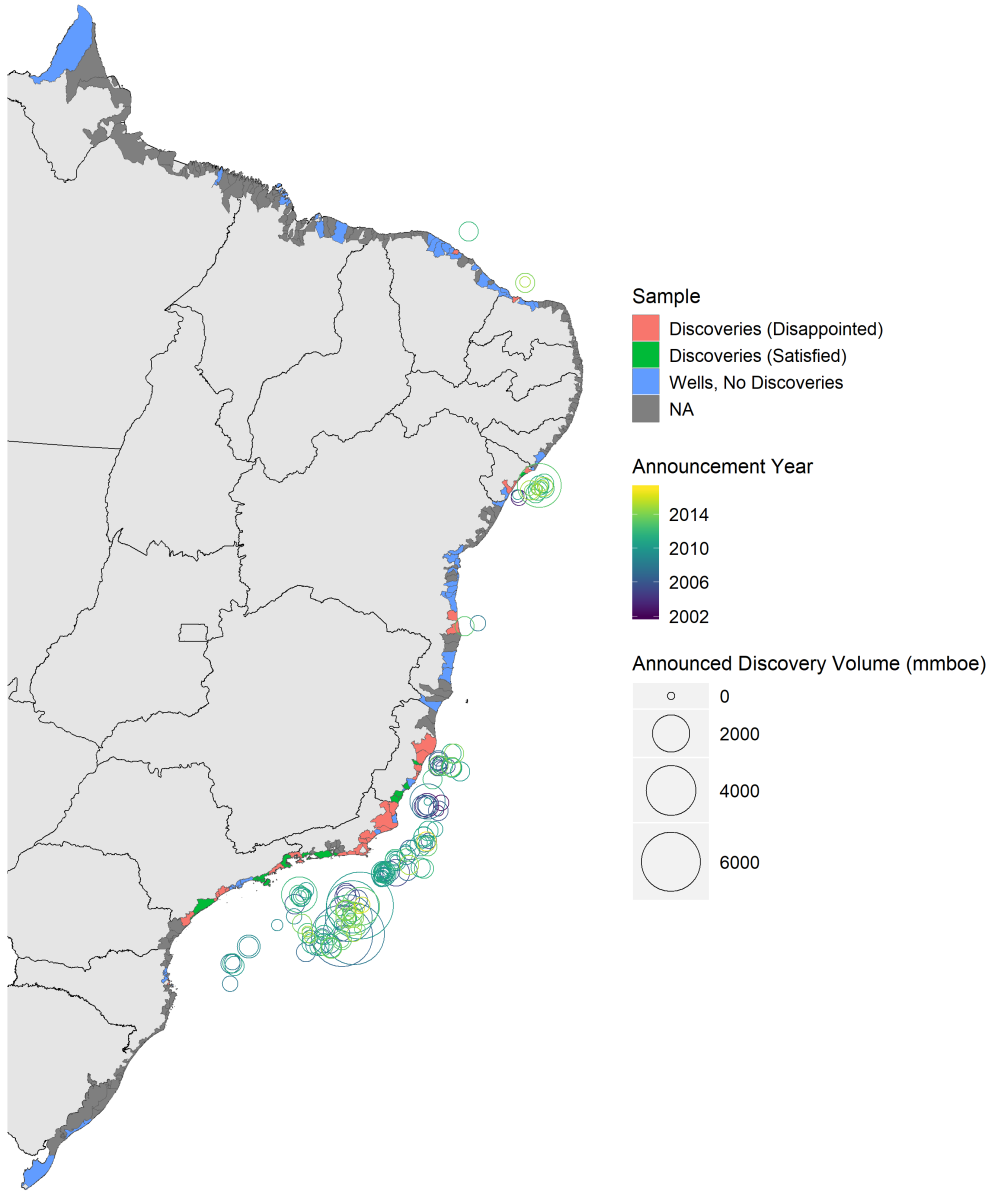
Pre-Treatment (Year 2000) Balance Between Samples

	Treated Samples		Control Samples			
	Disappoint.	**Satisfied**	**Wells**	**Match (D)**	**Match (S)**	**Coastal**
Latitude	-19.50	-21.82	-13.04	-20.21	-20.00	-16.40
	(6.25)	(3.13)	(9.59)	(7.91)	(8.13)	(9.24)
Dist. from State Capital	116.62	88.59	150.15	192.14	92.79	248.87
	(85.35)	(57.12)	(120.02)	(143.64)	(38.81)	(159.90)
Population (Thousands)	91.88	398.53	55.42	38.11	56.82	32.26
	(122.23)	(1,367.51)	(81.82)	(77.30)	(471.41)	(192.54)
GDP per capita	17,769	13,779	6,552	6,814	7,840	5,443
	(26,418)	(12,003)	(6,735)	(7,261)	(9,641)	(5,978)
Income Gini Coefficient	0.57	0.57	0.56	0.55	0.53	0.54
	(0.05)	(0.04)	(0.07)	(0.06)	(0.06)	(0.07)
Municipal Dev.Index	0.60	0.64	0.50	0.57	0.57	0.53
	(0.07)	(0.09)	(0.10)	(0.09)	(0.13)	(0.13)
Urban Share of Pop.	0.83	0.80	0.66	0.68	0.66	0.57
	(0.21)	(0.22)	(0.24)	(0.20)	(0.25)	(0.24)
% HHs w. Water/Sewer	7.76	3.63	20.56	10.03	10.67	13.64
	(8.01)	(3.95)	(19.57)	(12.19)	(15.81)	(16.19)
Municipal Revenue p.c.	1,628	1,729	1,011	969	1,220	1,000
	(1,478)	(1,047)	(809)	(2,993)	(3,840)	(1,496)
Municipal Oil Rev. p.c.	420.6	161.8	129.7	15.1	10.2	6.1
	(999.4)	(334.7)	(412.9)	(100.4)	(43.4)	(60.0)
Municipal Invest. p.c.	161.0	123.1	98.2	55.0	69.7	63.3
	(223.9)	(110.3)	(172.1)	(116.9)	(143.8)	(83.2)
n	30	18	53	836	500	3,902

Sample means with standard deviations in parentheses. Monetary values are deflated to constant 2010 Brazilian Reals.

▸ Return

Mapping Discovery Realizations (Full Brazilian Coastline)



▸ Return

Testing Conditional Random Assignment

Regress characteristic Y_m from baseline year 2000 on a vector of geographic controls, state FEs, and a treatment indicator that equals 1 if:

1. Municipality has wells drilled
2. A major discovery is announced in municipalities where wells were drilled
3. Expectations are satisfied in municipalities that received discovery announcements

$$Y_m^{2000} = \alpha + \beta_1 \mathit{Treatment}_m + X_m'\lambda + \delta_s + \epsilon_m$$

Conditional Random Assignment: Baseline Characteristics

	1(*Wells* = 1)	1(*Discovery* = 1)	1(*Satisfied* = 1)
Outcome	**p-value (FWER-adjusted)**	**p-value (FWER-adjusted)**	**p-value (FWER-adjusted)**
Population	0.261	0.661	0.206
	(0.817)	(0.994)	(0.804)
GDP	0.016	0.902	0.235
	(0.135)	(0.995)	(0.804)
Municipal Develop. Index	0.192	0.163	0.183
	(0.777)	(0.684)	(0.804)
Urban Share of Population	0.484	0.600	0.123
	(0.974)	(0.993)	(0.725)
Income per capita	0.022	0.673	0.404
	(0.135)	(0.994)	(0.804)
Income Gini Coefficient	0.858	0.017	0.192
	(0.992)	(0.119)	(0.804)
% Employed in Extractive	0.046	0.802	0.226
	(0.135)	(0.995)	(0.804)
% Formally Employed	0.667	0.496	0.450
	(0.92)	(0.988)	(0.804)
% Homes w. Water & Sewer	0.755	0.823	0.958
	(0.992)	(0.995)	(0.961)
Sample	Municipalities on Coast	Municipalities w. Wells	Municipalities w. Discoveries
Observations	277	101	48

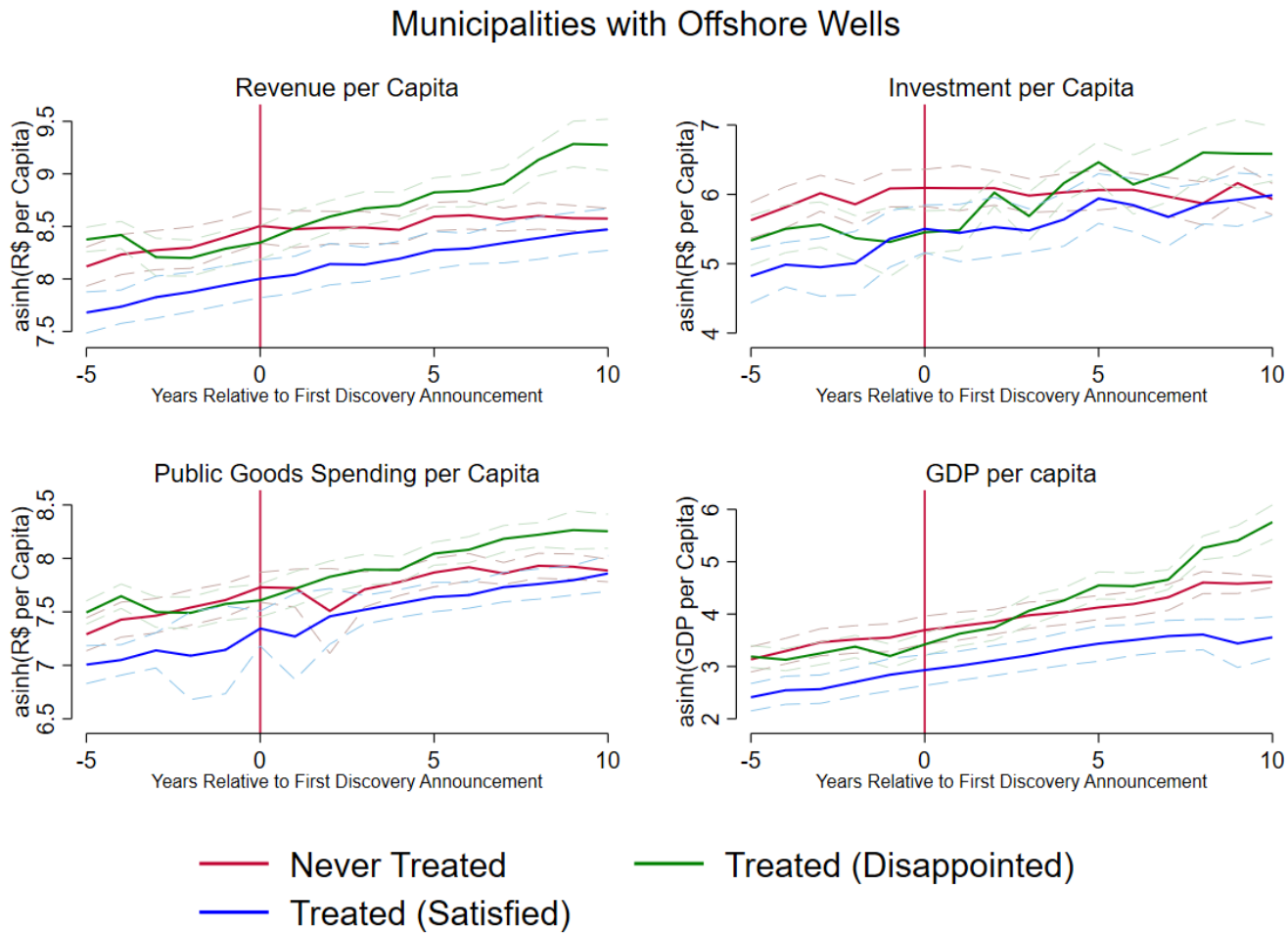
Each row is separate OLS regression with geographical controls and state FEs. Outcomes measured in 2000. FWER-corrected Romano-Wolf p-values in parentheses.

Conditional Random Assigment: Political Alignment

	1(*Wells* = 1)	1(*Discovery* = 1)	1(*Satisfied* = 1)
Outcome	**p-value (FWER-adj.)**	**p-value (FWER-adj.)**	**p-value (FWER-adj.)**
Cumulative Party Align. w. Governor	0.417	0.604	0.926
	(0.668)	(0.879)	(0.937)
Cumulative Party Align. w. President	0.953	0.680	0.160
	(0.963)	(0.879)	(0.521)
State Capital Dummy	0.091	0.745	0.198
	(0.283)	(0.879)	(0.521)
Contemp. Party Align. w. Governor	0.745	0.387	NA
Contemp. Party Align. w. President	0.558	0.550	NA
State Capital Dummy	0.000	0.973	NA
Sample	Municipalities on Coast	Municipalities w. Wells	Municipalities w. Discoveries
Observations	277	101	48

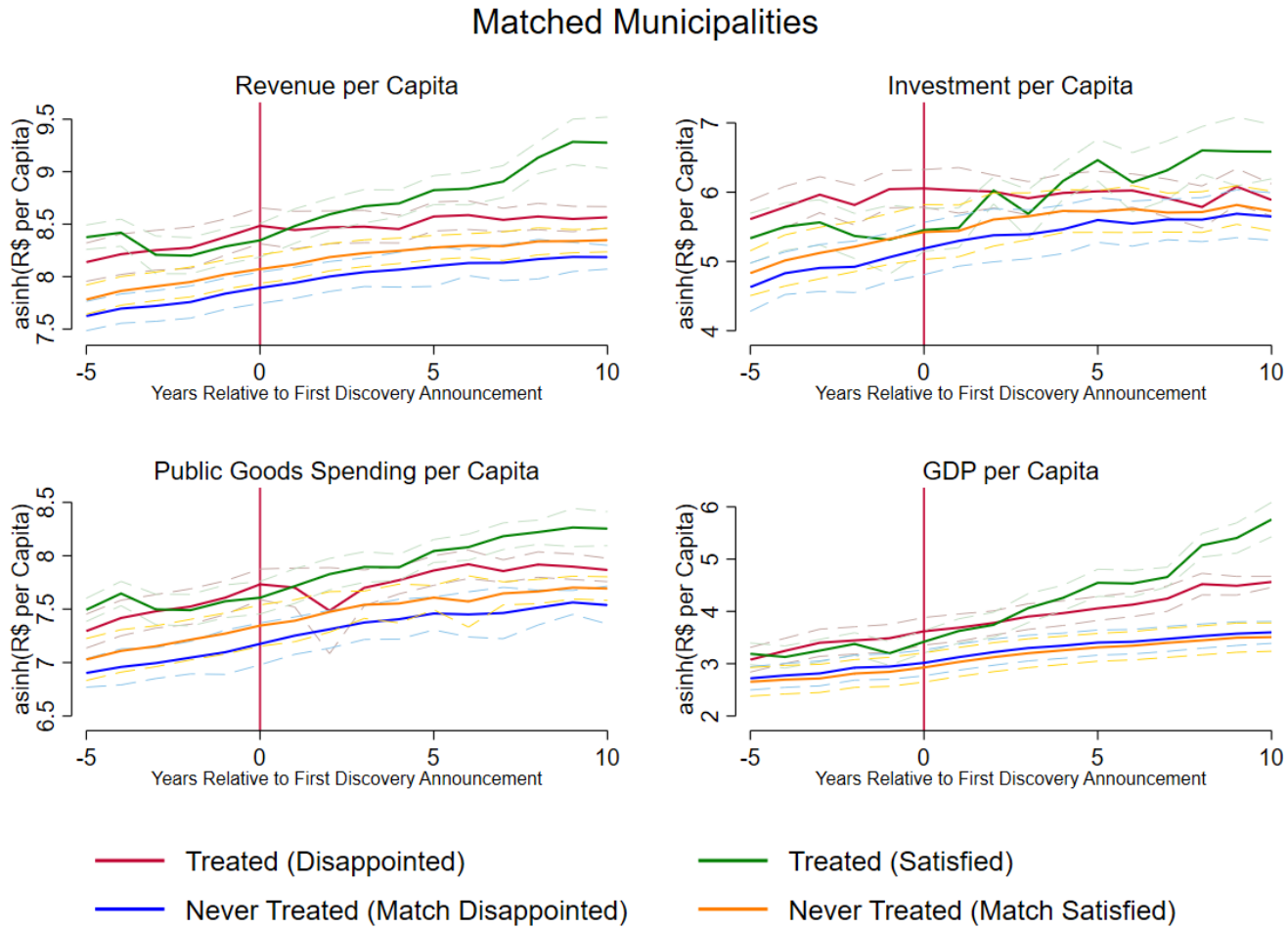
- Cumulative party alignment measures number of years between 2000-2017 in which municipal mayor was of same party as governor/president.
- Contemporaneous party alignment is indicator equal to 1 in years where municipal mayor's party is the same as governor/president's party.
- Each row is separate OLS regression with geographical controls and state FEs. FWER-corrected Romano-Wolf p-values in parentheses. ▸ Return

Pre-Trends for Disappointed, Satisfied, and Never Treated (Wells but no Discoveries) Municipalities



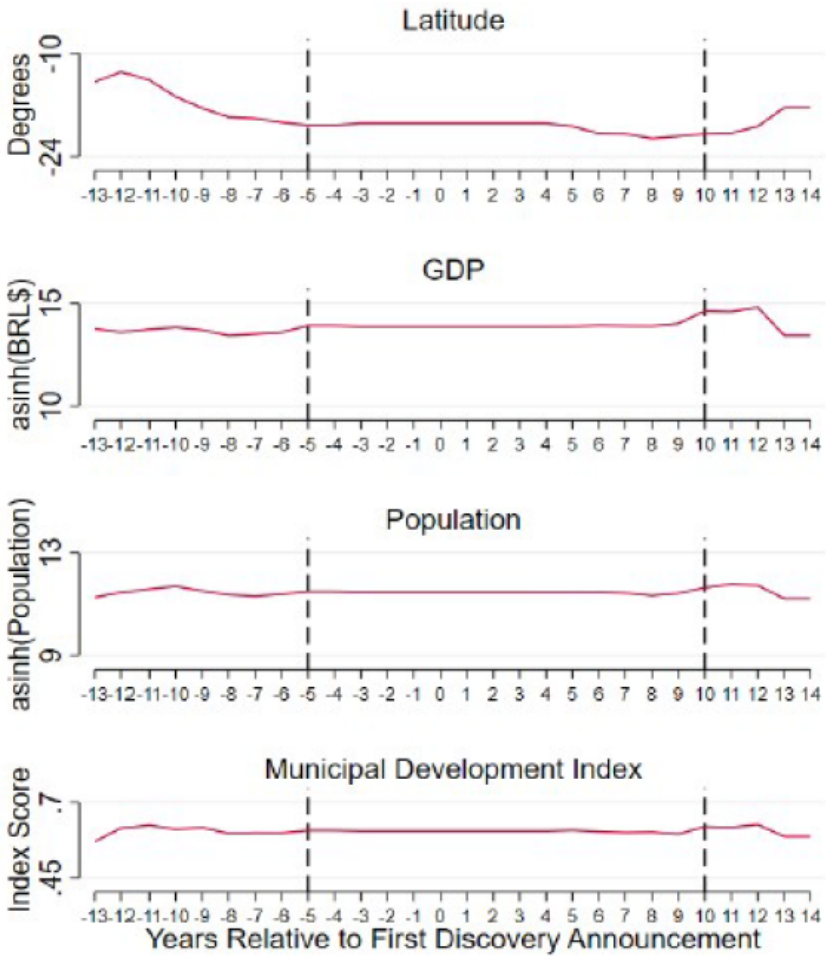
▶ Return

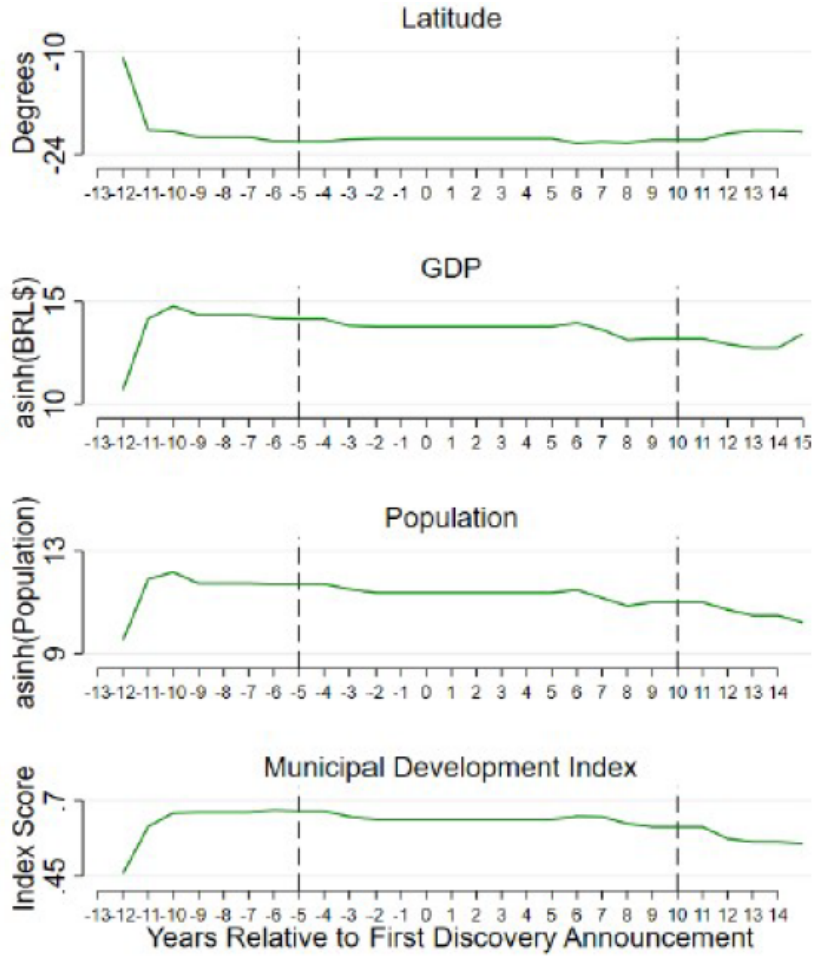
Pre-Trends for Disappointed, Satisfied, and Never Treated (Pre-Matched) Municipalities



▶ Return

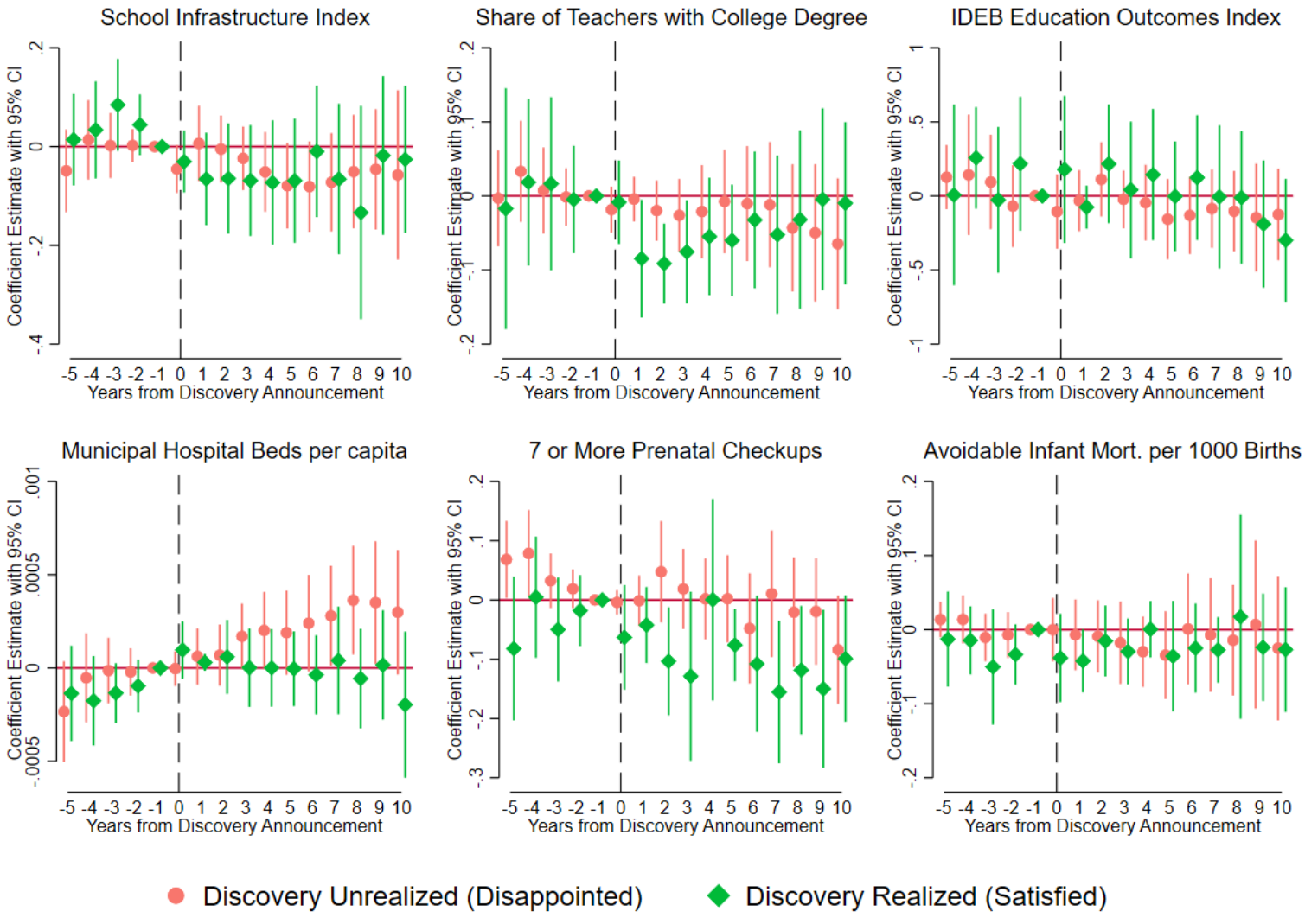
Sample Means Across Unbalanced Panel





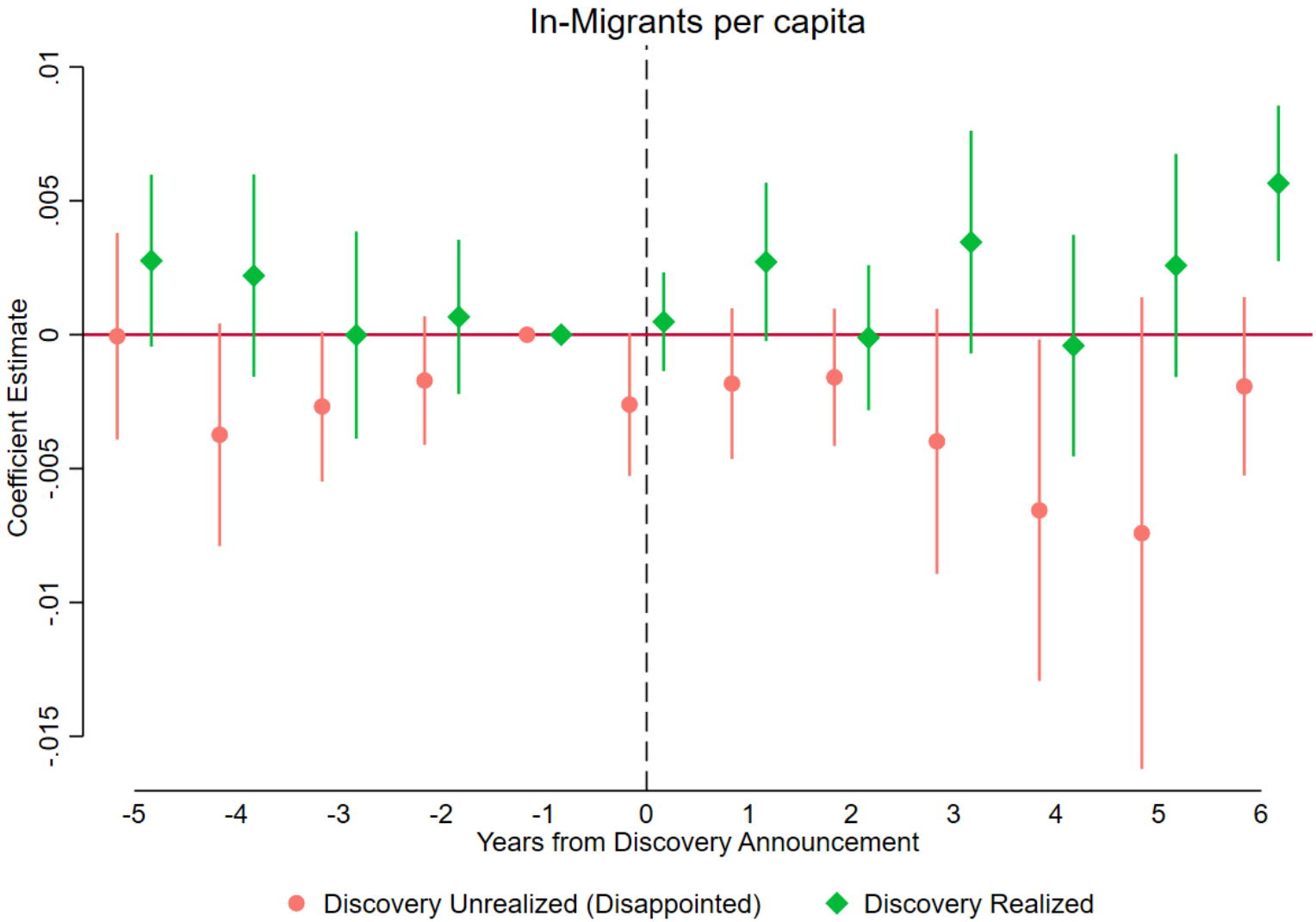
▸ Return

Results: Public Goods Provision and Quality



▸ Return

Results: In-Migration (up to 2010)



▸ Return

Satisfied Municipalities: Robustness Across Samples and Estimators

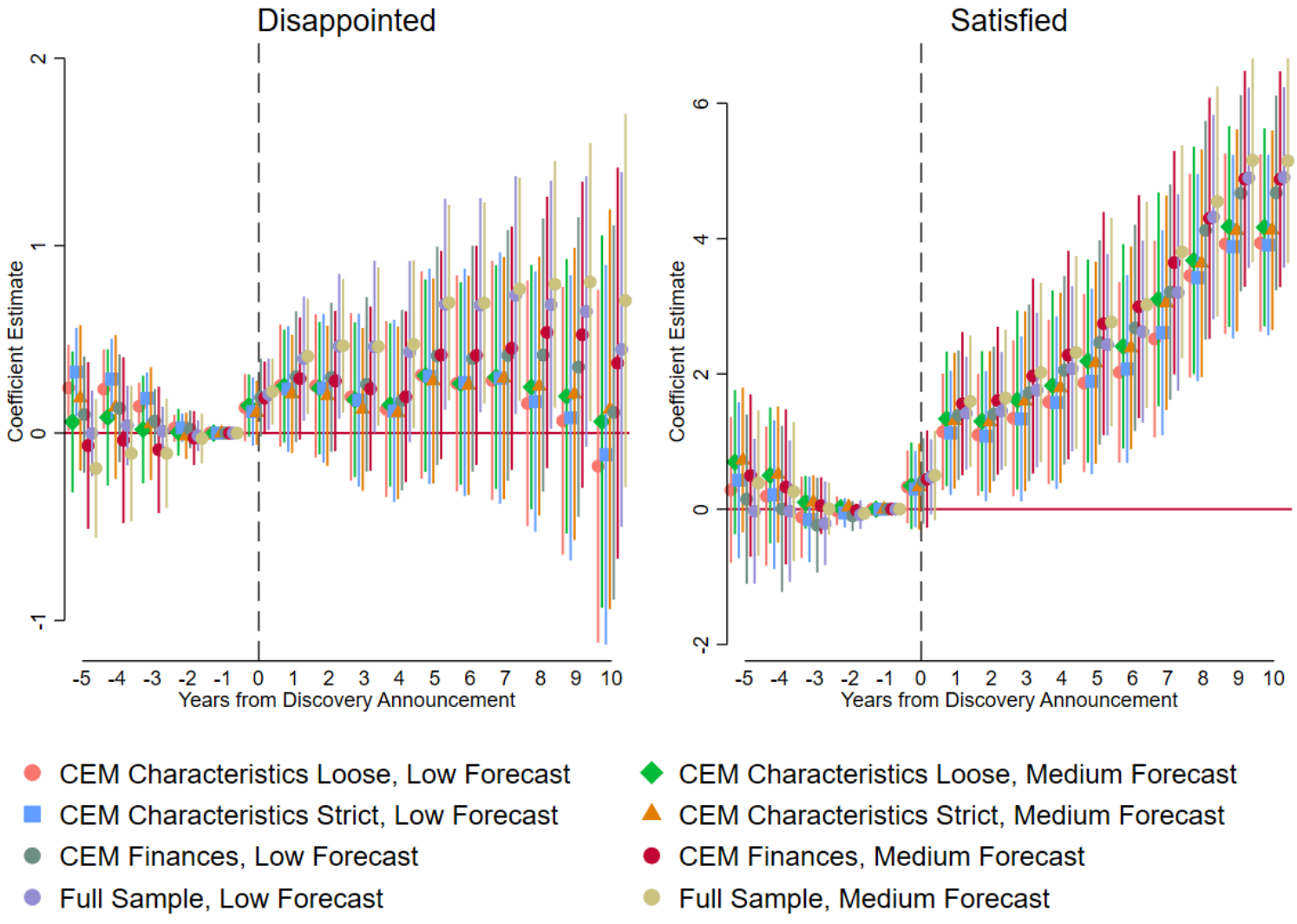
	TWFE Wells	TWFE Pre-Matching	CS Wells	CS Pre-Matching
Total Revenue (Millions)	0.65***	0.83***	0.76***	0.89***
	(0.20)	(0.19)	(0.25)	(0.29)
Revenue p.c.	0.66***	0.77***	0.74***	0.87***
	(0.20)	(0.19)	(0.25)	(0.28)
Tax Revenue p.c.	-0.21	0.07	0.02	0.22
	(0.30)	(0.26)	(0.29)	(0.31)
Oil Revenue p.c.	4.35***	4.49***	4.69***	4.45***
	(0.68)	(0.69)	(0.95)	(1.01)
Transfer Revenue p.c.	0.04	0.08	0.05	0.04
	(0.05)	(0.05)	(0.06)	(0.06)
Spending p.c.	0.25**	0.38***	0.25**	0.43***
	(0.12)	(0.11)	(0.11)	(0.13)
Investment p.c.	0.82	0.92	1.44*	1.43
	(0.71)	(0.72)	(0.82)	(0.96)
Personnel Spending p.c.	0.19*	0.32***	0.26**	0.50***
	(0.11)	(0.10)	(0.12)	(0.13)
Education Spending p.c.	0.35*	0.41**	0.35***	0.45***
	(0.20)	(0.19)	(0.13)	(0.10)
Health Spending p.c.	0.34	0.31	0.42**	0.35*
	(0.23)	(0.19)	(0.19)	(0.19)
GDP p.c.	1.42***	1.51***	1.59***	1.82**
	(0.31)	(0.30)	(0.53)	(0.71)
n (municipality-years)	1,278	9,012	1,278	9,012

Each column reports coefficient estimates and standard errors for the t + 10 period of event studies for a specific control group-estimator pair.

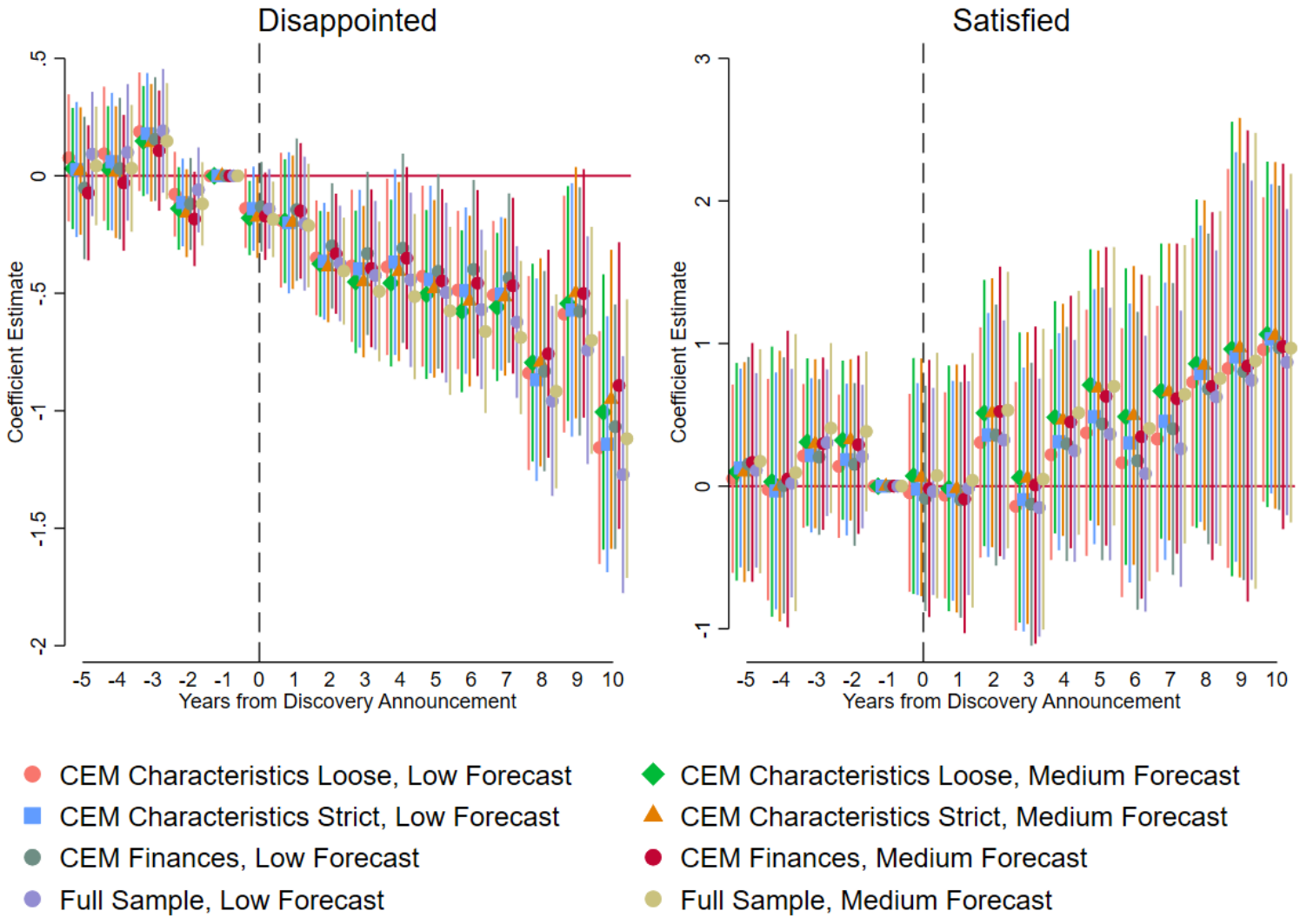
*** p<0.01, ** p<0.05, * p<0.1

▸ Interpreting Coefficients ▸ Return

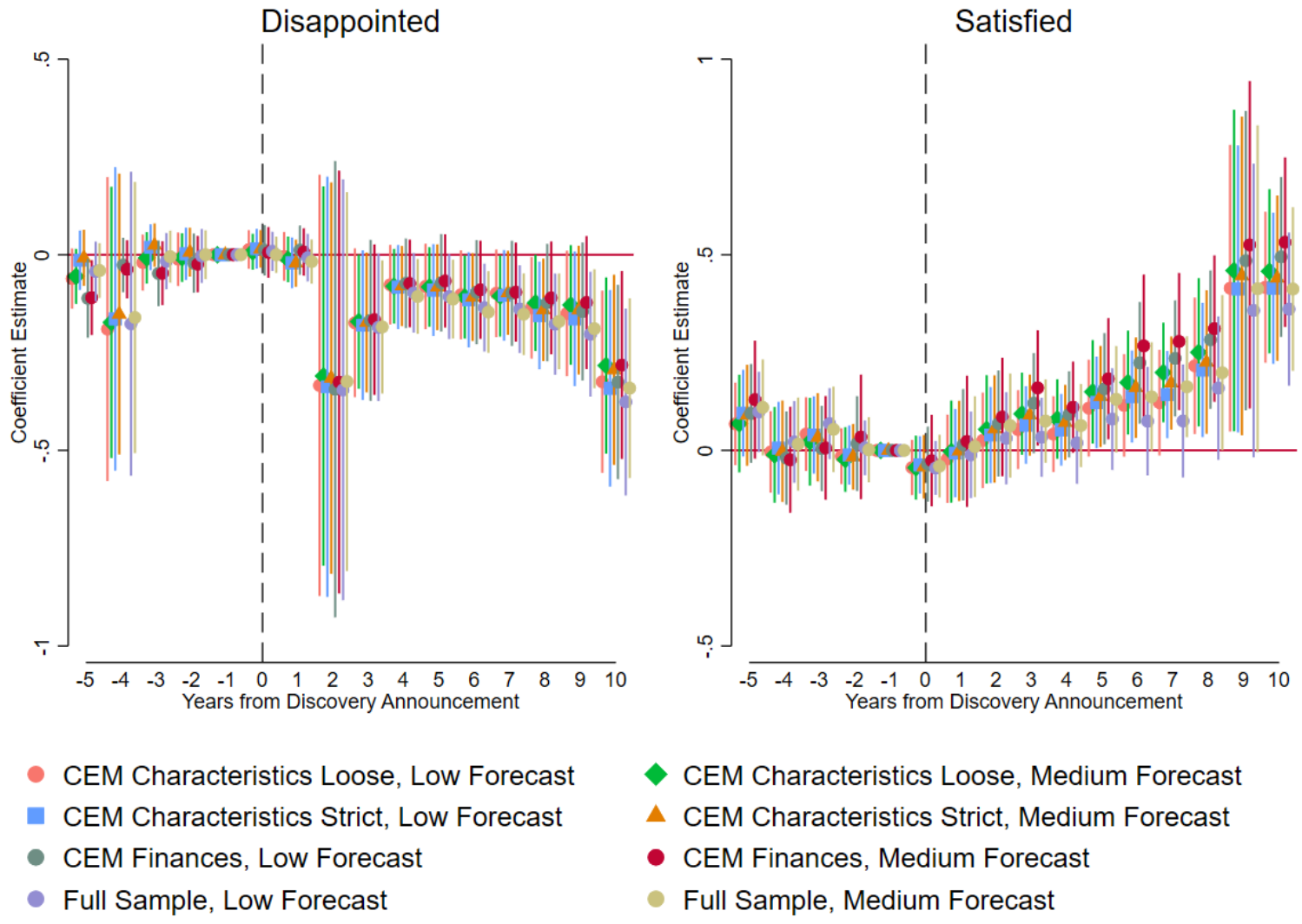
Robustness to Alternative Forecasting and Matching Parameters: Oil Revenues



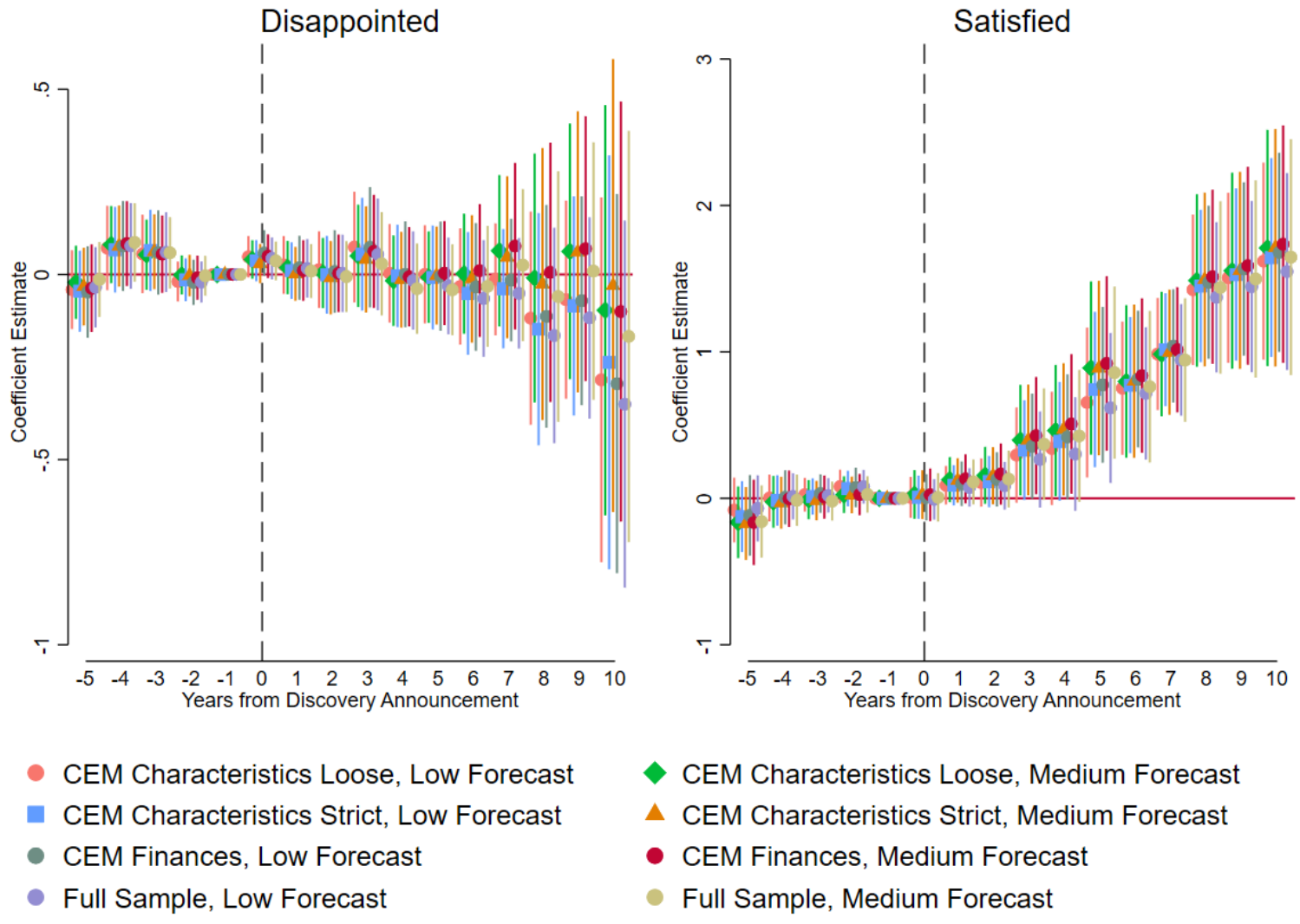
Robustness to Alternative Forecasting and Matching Parameters: Investment



Robustness to Alternative Forecasting and Matching Parameters: Education Spending



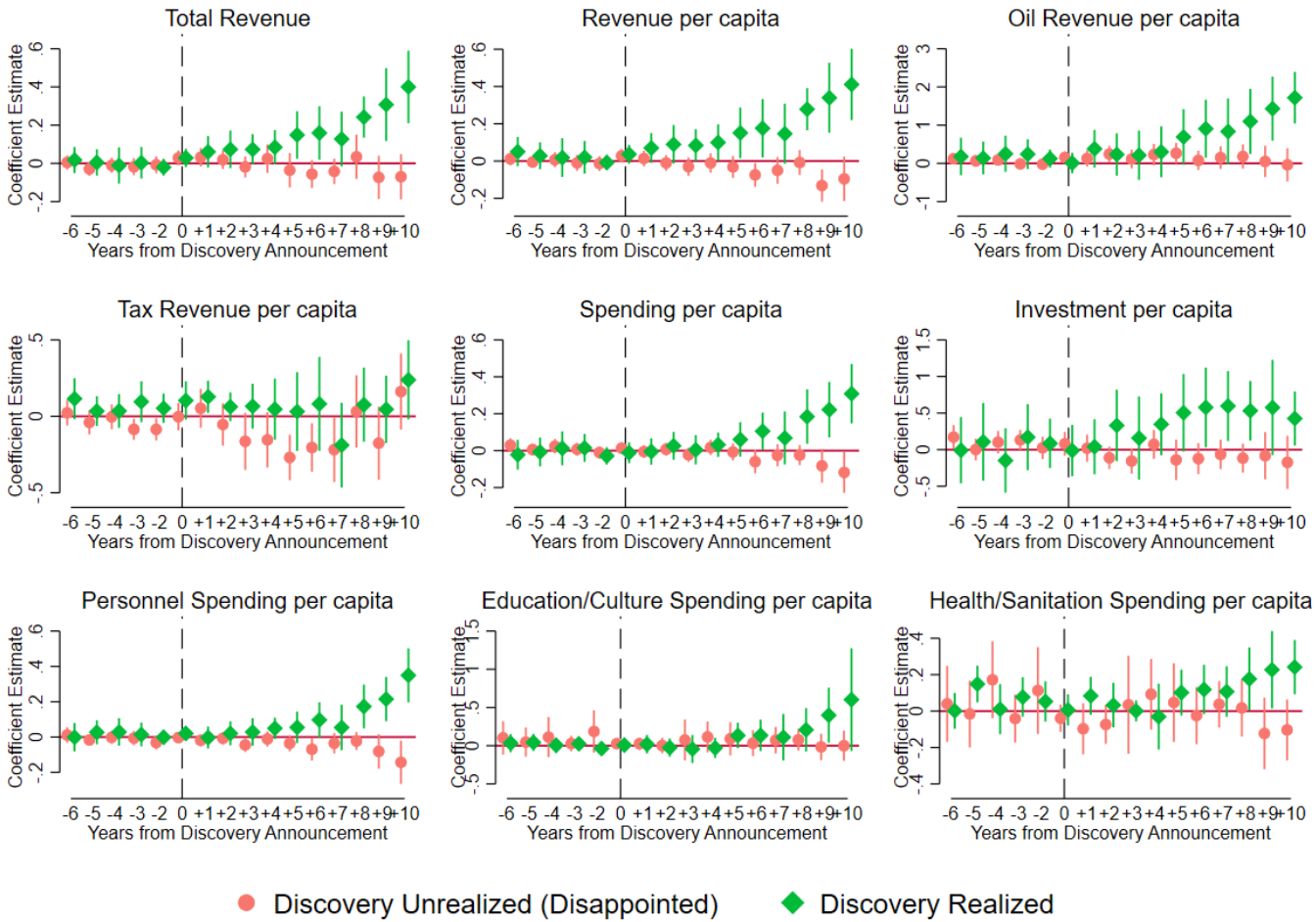
Robustness to Alternative Forecasting and Matching Parameters: GDP



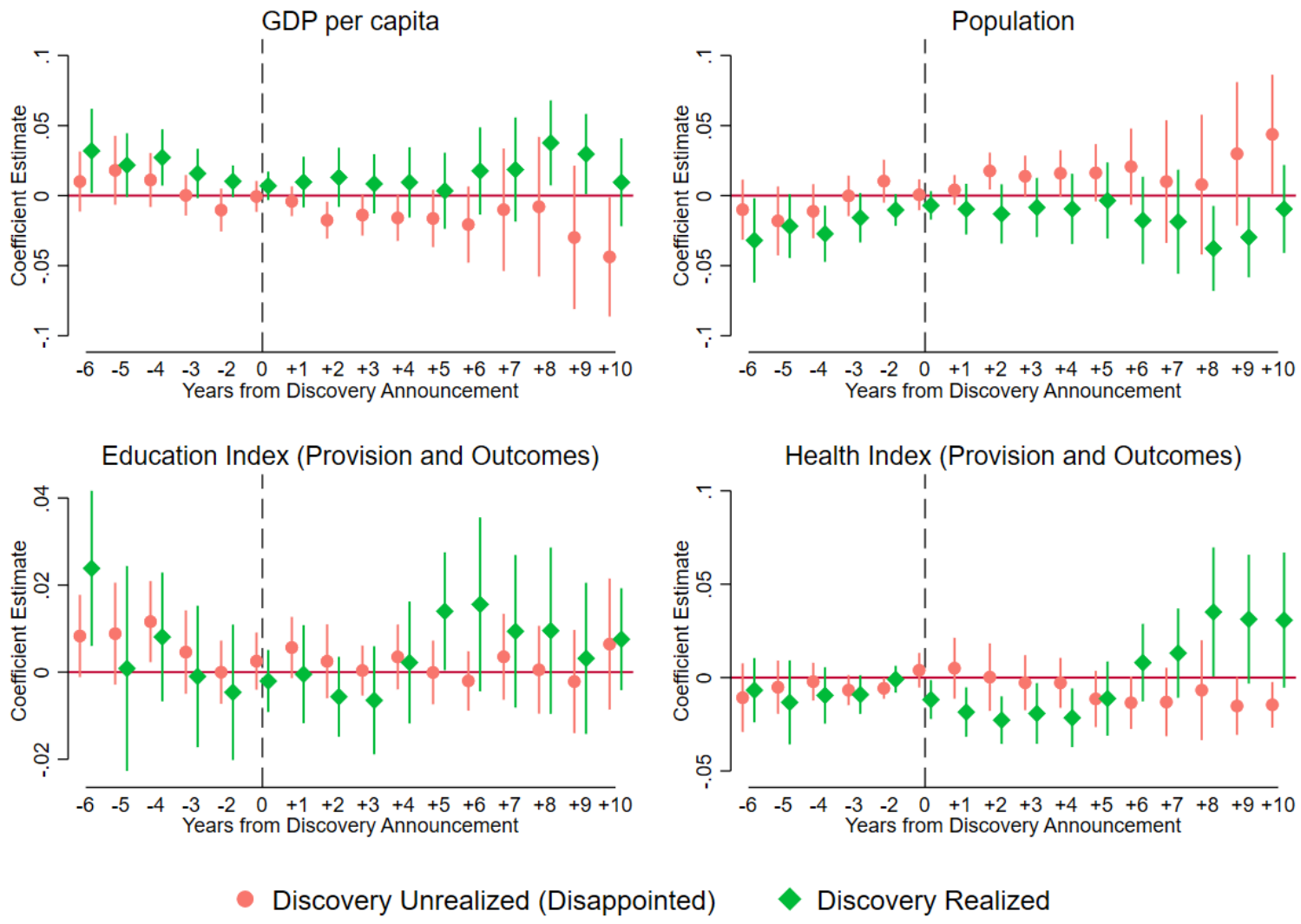
Appendices ▶ Return

Event Studies With Multiple Events

I estimate event study specifications equivalent to those in the main study, but turn on relative time indicators for each event that affects municipality *m* during the sample period. Multiple relative time indicators can be turned on at once (e.g., if events occur in 2005 and 2010, in 2008 both t+3 and t-2 indicators will be turned on.



Event Studies With Multiple Events Continued

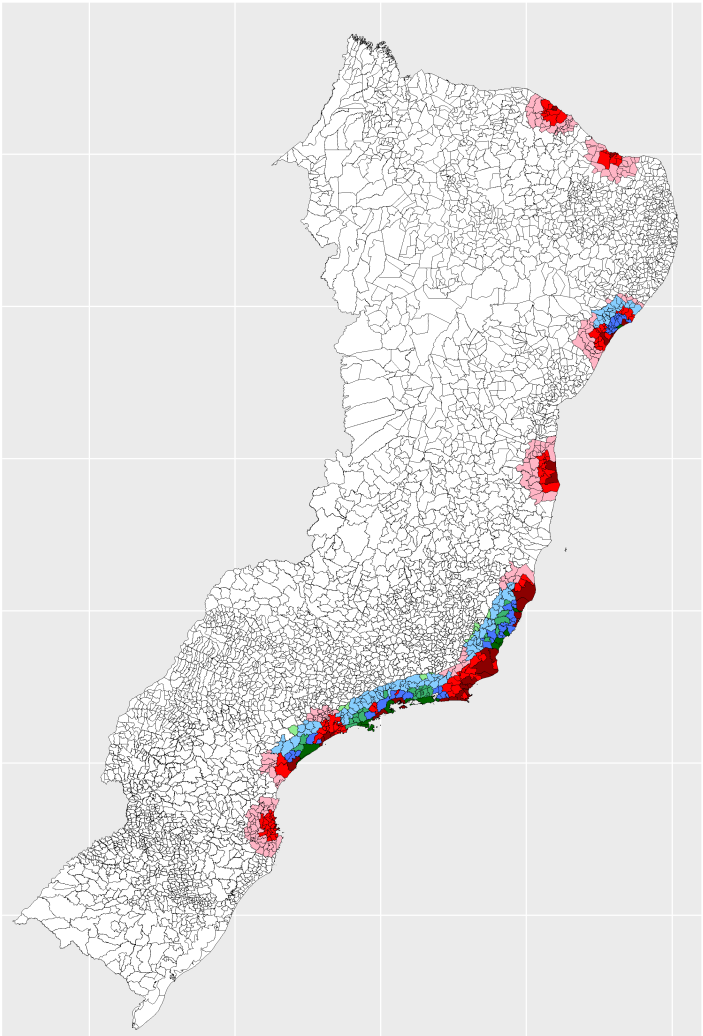


▸ Return

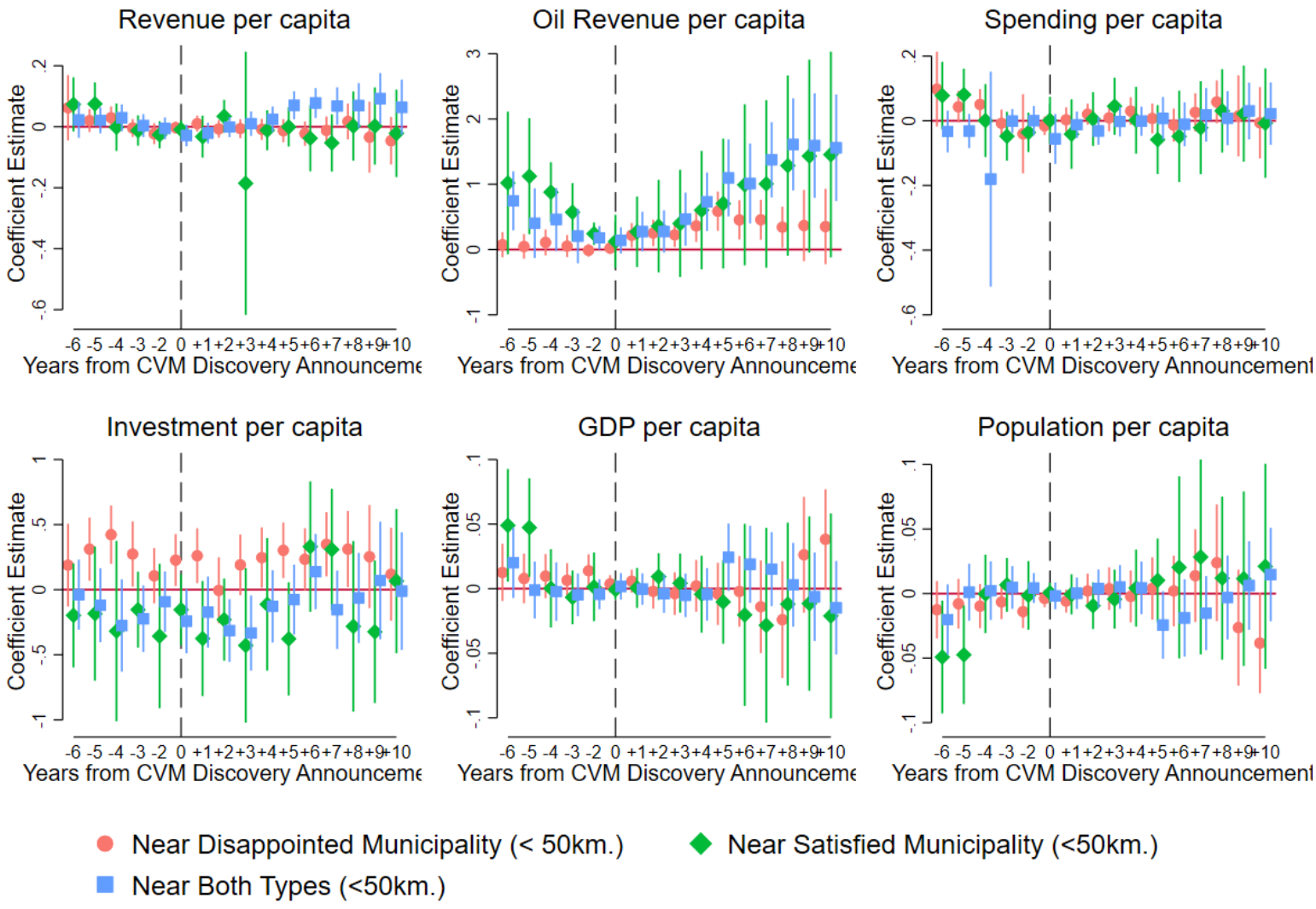
Spatial Spillovers Onto Neighboring Municipalities

- Identify municipalities that are (i) near/far (0-50 and 50-100km) from disappointed municipalities; (ii) near/far from satisfied municipalities; (iii) near/far both

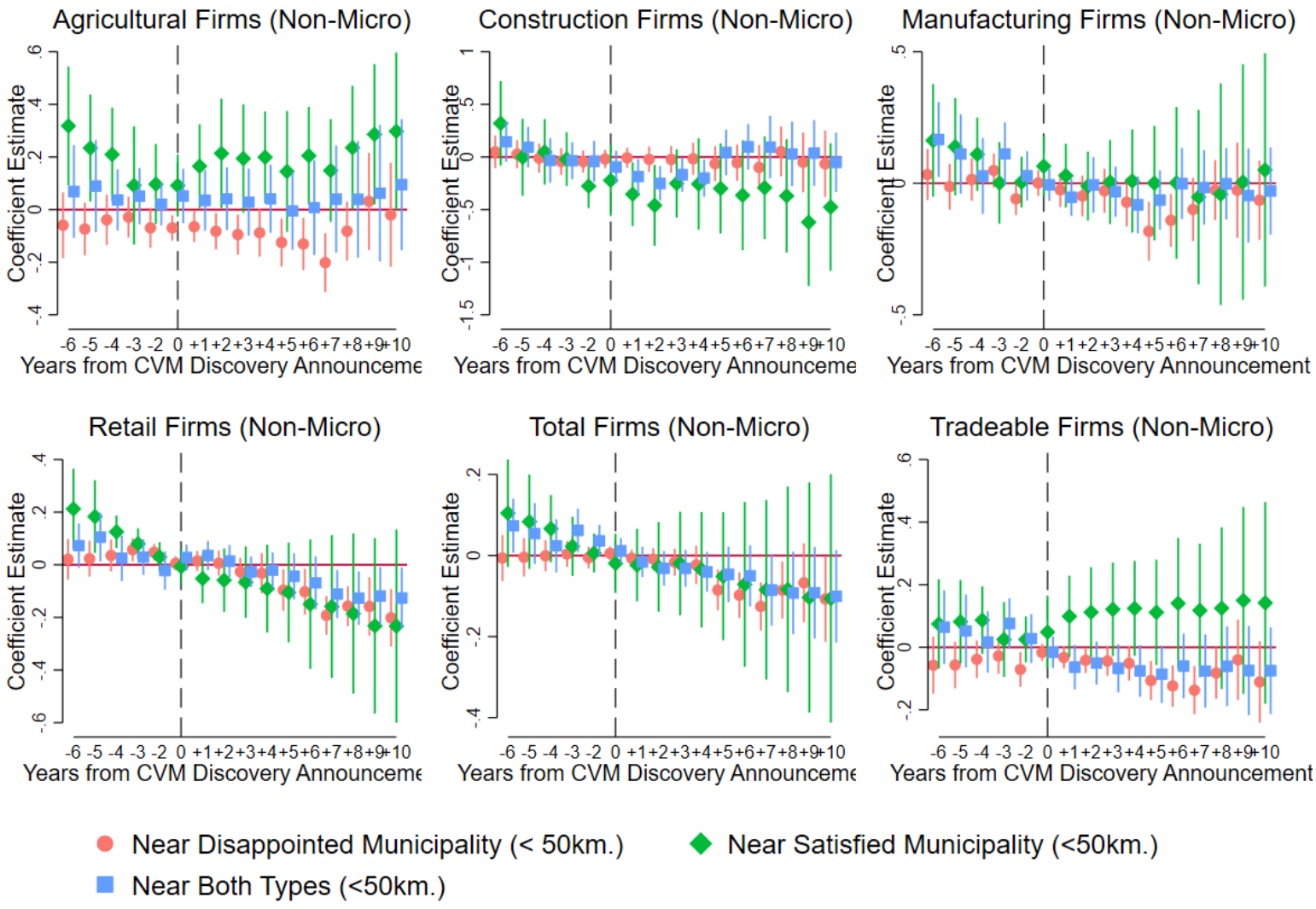
- Estimate event studies where near groups are "treated" and far groups are controls



Spatial Spillovers: Effects on Public Finances

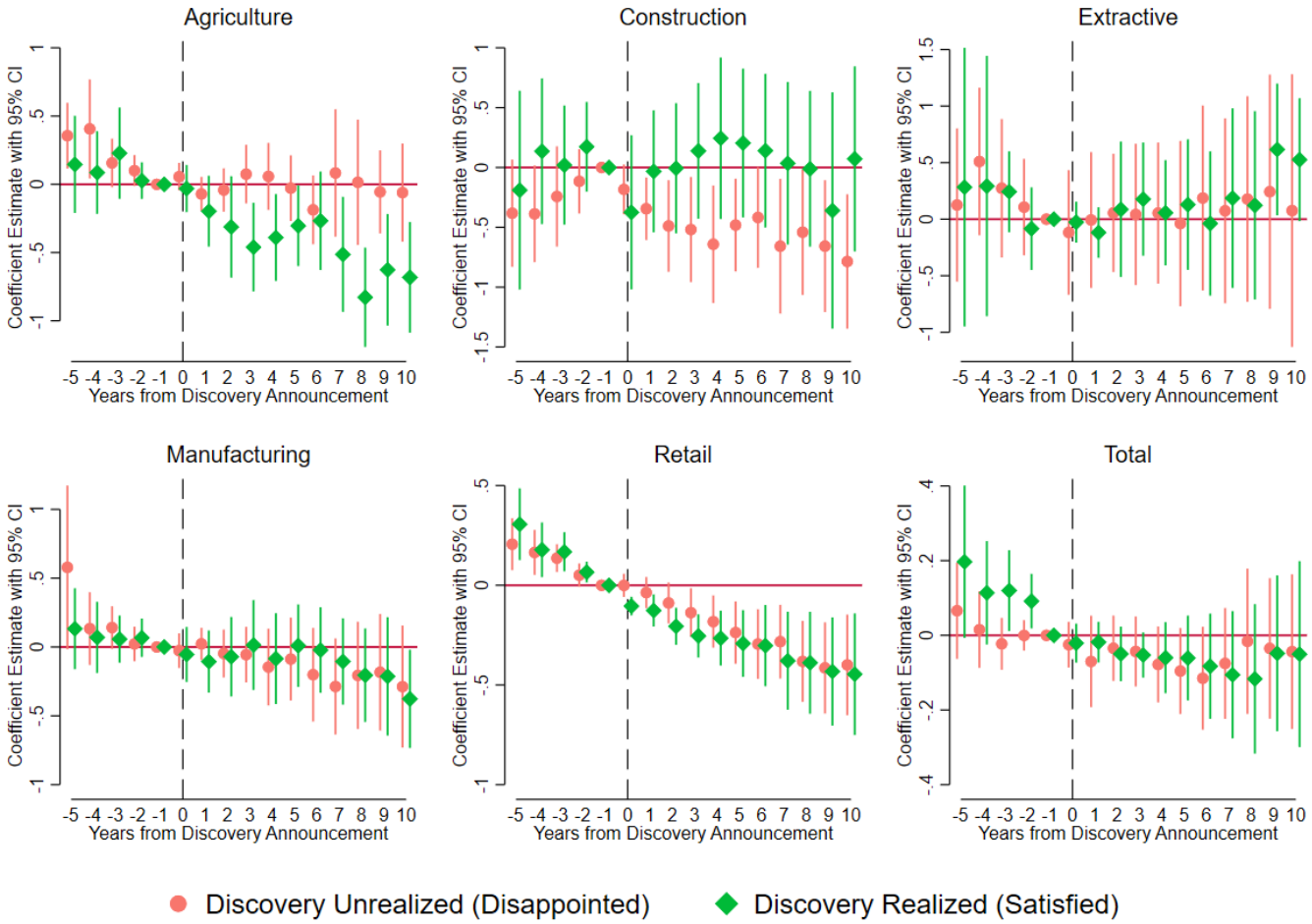


Spatial Spillovers: Effects on Firm Entry

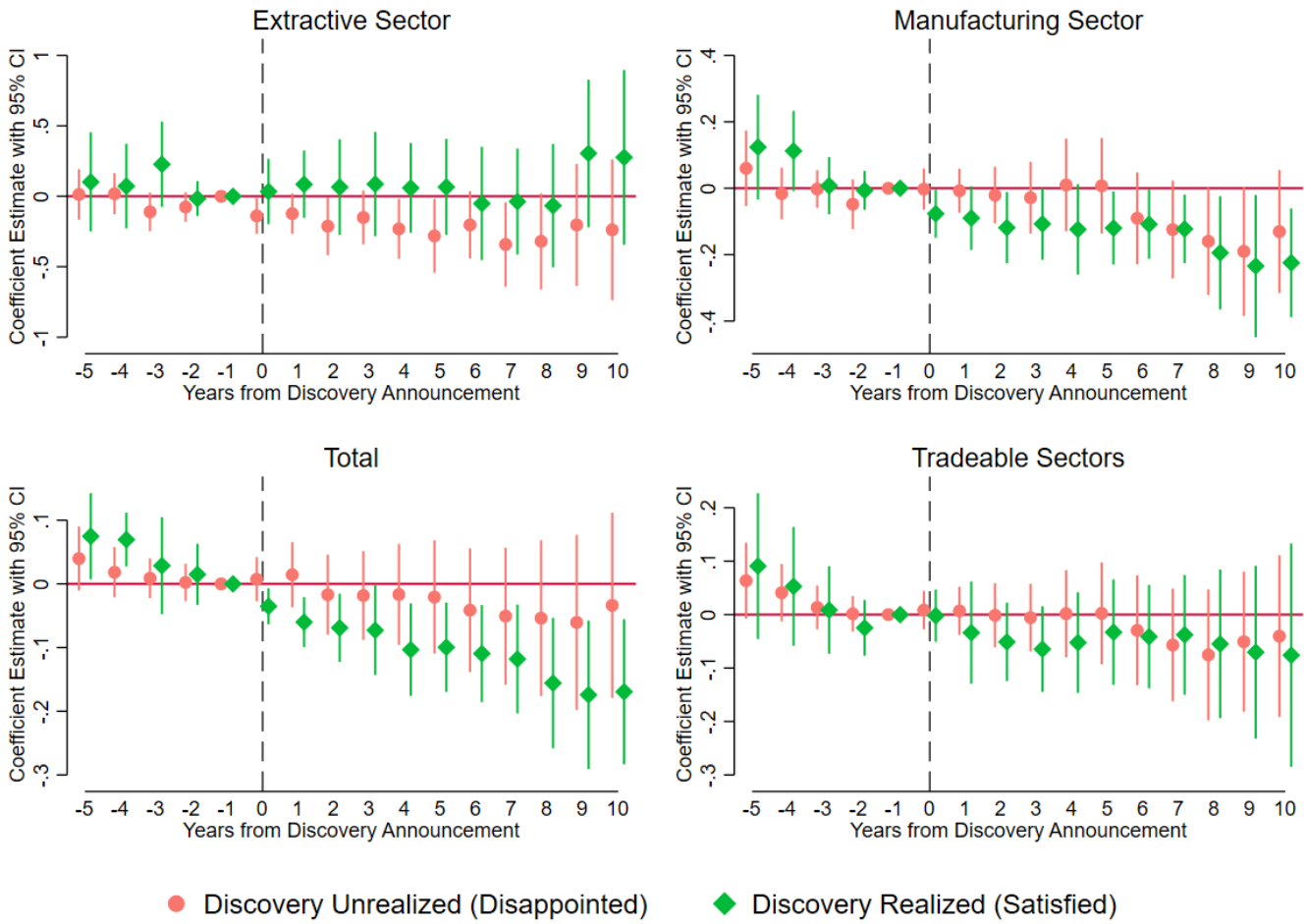


▸ Return

Discovery Effects on Formal Employment

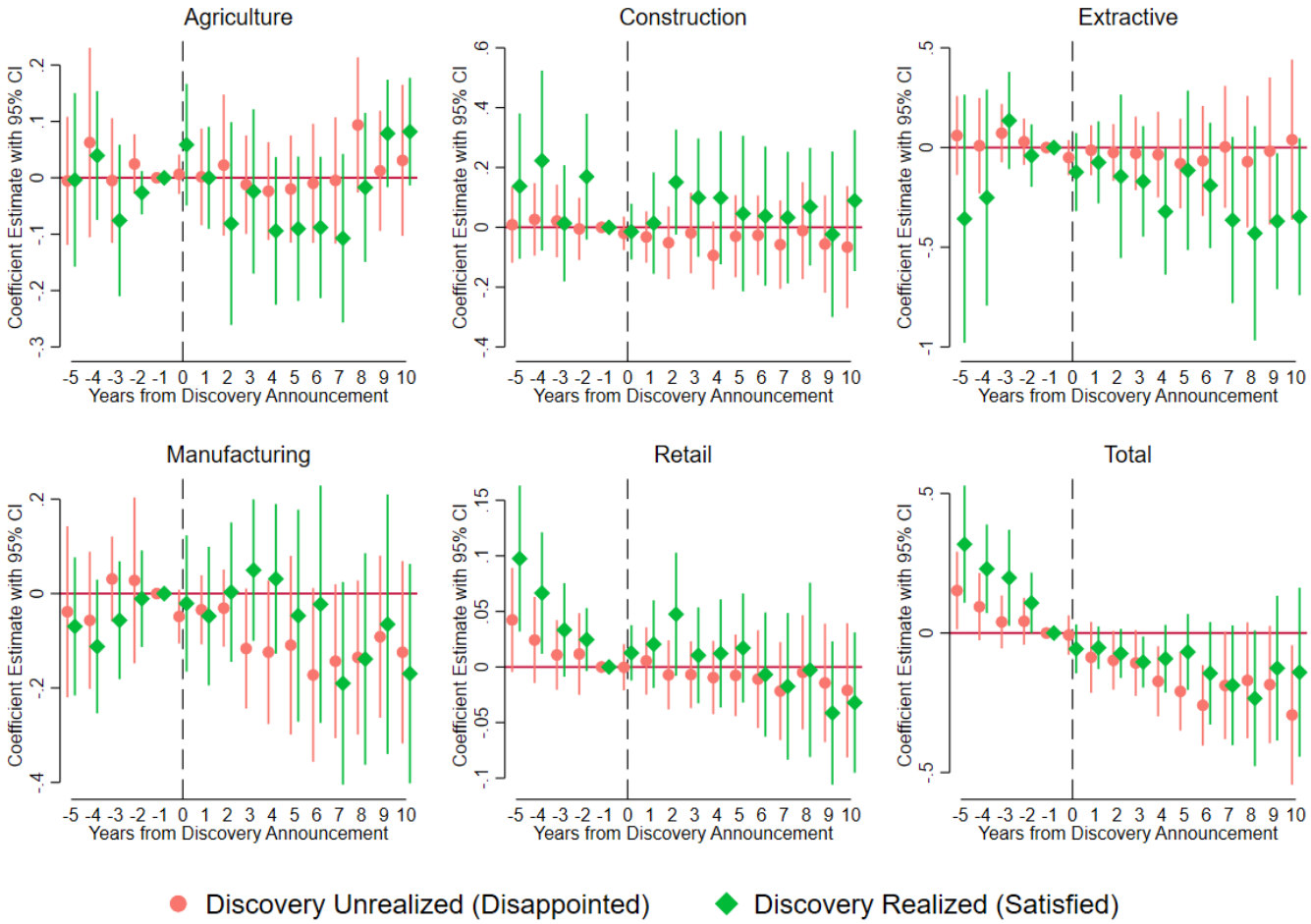


Discovery Effects on Firm Entry



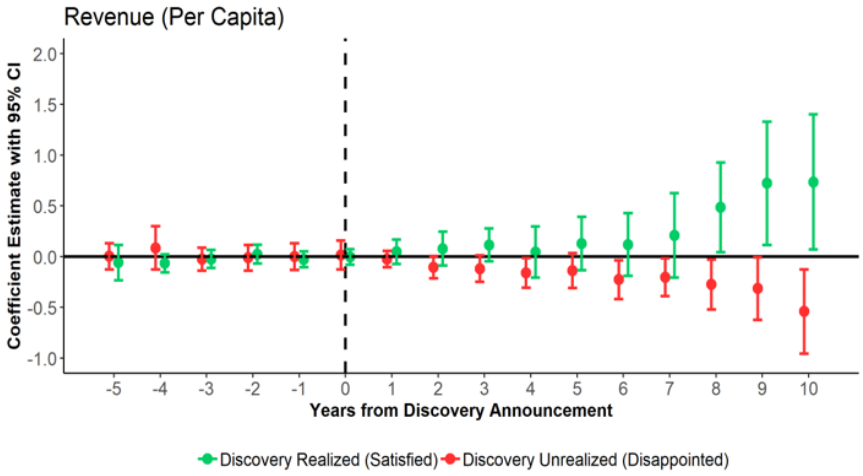
▶ Return

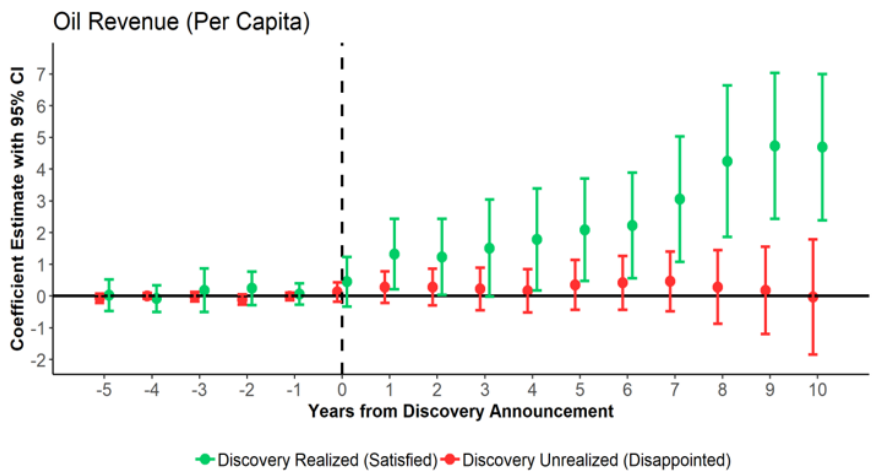
Discovery Effects on Formal Wages



▶ Return

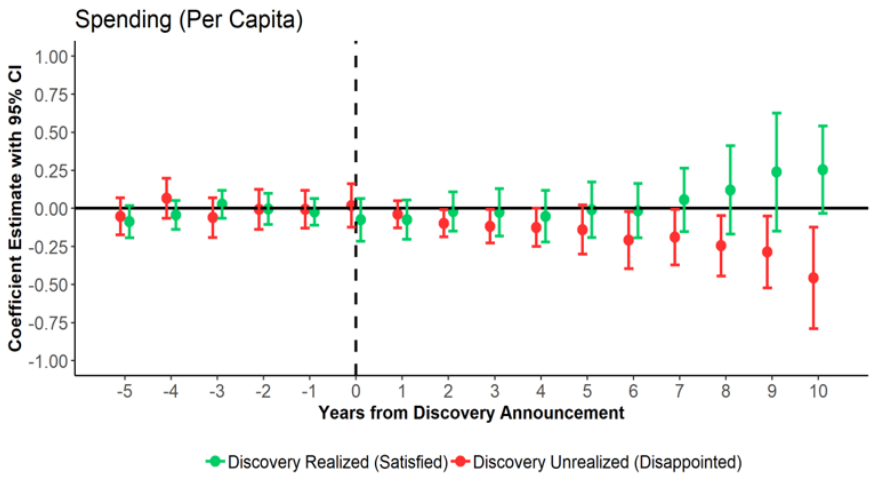
CS Estimator: Total Revenue and Oil Revenue per capita

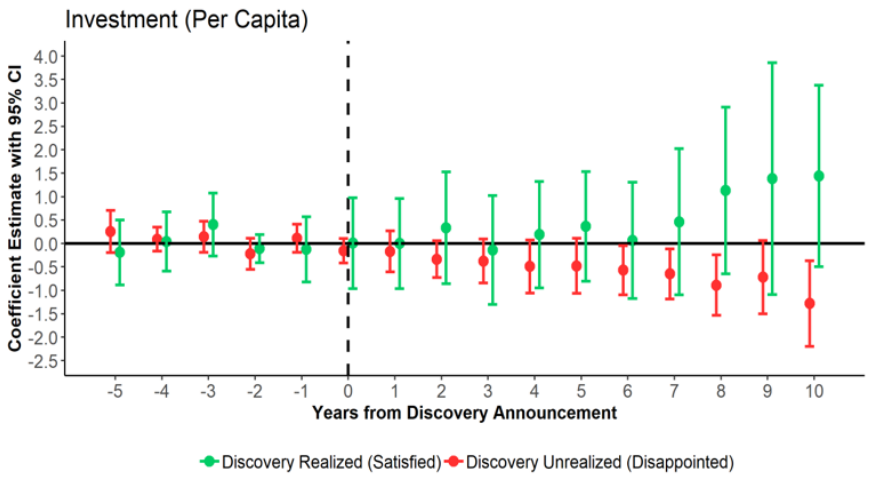




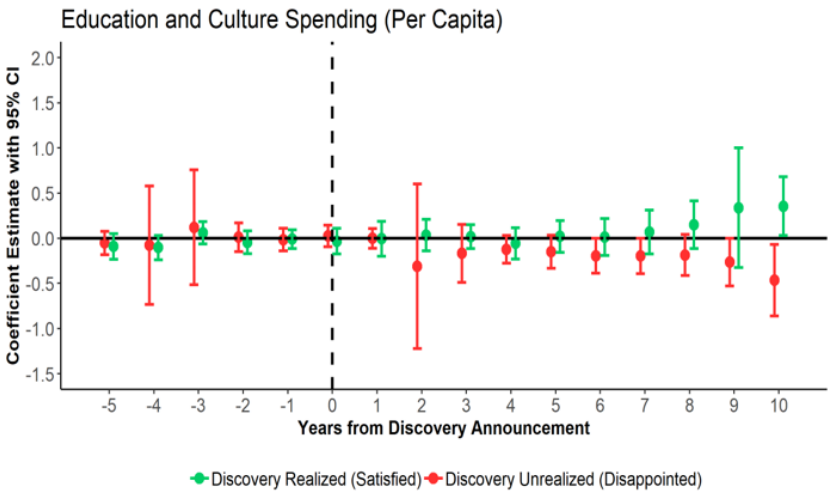
Callaway and Sant'Anna Event Studies Cont'd.

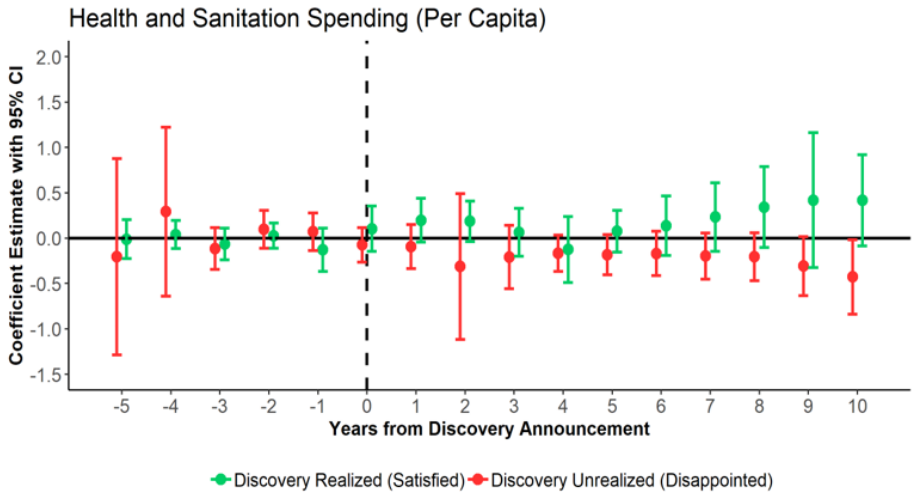
CS Estimator: Spending and Investment per capita





CS Estimator: Education and Health Spending per capita



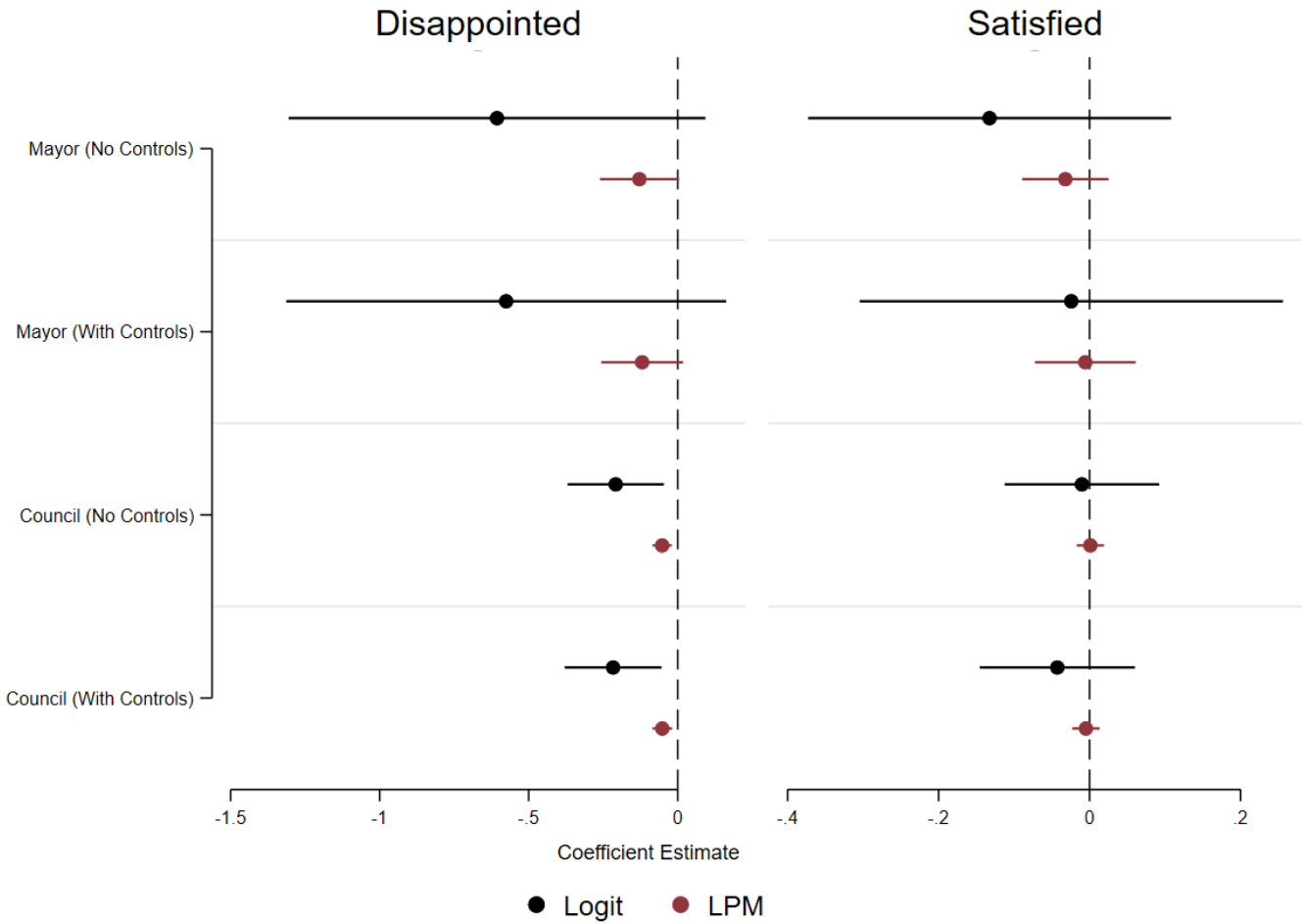


▶ Return

Do Voters Punish Incumbents for Discovery Disappointment?

Estimate likelihood of reelection for incumbent i in municipality m and election period e:

$$P(Reelection_{ime} = 1) = \delta_m + \lambda_e + \beta Disappointed_{me} + X_i' \mu + \epsilon_{ime}$$



Electoral Competition: Robustness Across Samples and Estimators

	TWFE Wells	TWFE Pre-Match	CS Wells	CS Pre-Match
Council Candidates (Total)	0.131	0.046	0.172	0.070*
	(0.122)	(0.032)	(0.235)	(0.037)
Council Candidates (Compet.)	0.070	0.061*	0.098*	0.066
	(0.061)	(0.034)	(0.105)	(0.037)
Mayoral Candidates (Total)	0.041	0.035	0.065	0.054
	(0.052)	(0.048)	(0.068)	(0.050)
Mayoral Candidates (Compet.)	0.001	0.008	-0.129***	-0.087*
	(0.046)	(0.047)	(0.045)	(0.046)
Comp. Council Cand. Per Seat	0.047**	0.038**	0.068***	0.033
	(0.019)	(0.018)	(0.025)	(0.022)
Avg. Coalition Size	-0.081**	-0.078***	-0.118*	-0.077*
	(0.037)	(0.028)	(0.062)	(0.041)
Total Number of Donations	0.169*	0.149	0.157*	0.164**
	(0.087)	(0.091)	(0.092)	(0.069)
Total Value of Donations	0.131*	0.119	0.238**	0.114
	(0.078)	(0.083)	(0.120)	(0.113)
Number of Donations per Cand.	0.166**	0.124	0.106	0.040
	(0.080)	(0.081)	(0.095)	(0.086)
Value of Donations per Cand.	0.132	0.095	0.195	-0.006
	(0.082)	(0.085)	(0.137)	(0.128)
Share of Candidates Female	-0.008	-0.016***	-0.010	-0.006
	(0.007)	(0.005)	(0.010)	(0.120)
Avg. Candidate Age	0.001	-0.002	-0.031**	0.000
	(0.005)	(0.004)	(0.014)	(0.011)
Avg. Candidate Schooling	-0.030***	-0.024***	-0.031**	-0.009
	(0.009)	(0.006)	(0.014)	(0.010)
Municipality FEs	Y	Y	Y	Y
Election Period FEs	Y	Y	Y	Y
n (municipality-election periods)	404	3,745	404	3,745

Appendices ▶ Return

Coefficients and Elasticities (Disappointed)

	Sample Properties			Coefficients			Small-n Bias Correct. Elast.		
Outcomes	$\overline{X}$	**n**	**Units**	**1 Year**	**5 Years**	**10 Years**	**1 Year**	**5 Years**	**10 Years**
Total Revenue (Millions)	162	1,392	83	0.00	-0.04	-0.20**	-0.64	-6.28	-20.79***
				(0.02)	(0.04)	(0.08)	(2.12)	(3.92)	(6.02)
Revenue p.c.	2,086	1,392	83	-0.01	-0.10	-0.26**	-2.13	-11.86**	-26.69***
				(0.02)	(0.06)	(0.11)	(2.14)	(5.44)	(8.02)
Tax Revenue p.c.	220	1,392	83	0.14*	-0.23	-0.35	10.93	-27.00**	-37.30***
				(0.08)	(0.17)	(0.23)	(8.75)	(12.09)	(14.28)
Oil Revenue p.c.	473	1,494	83	0.27	0.34	0.16	19.75	20.33	-5.57
				(0.17)	(0.31)	(0.43)	(20.87)	(37.60)	(40.41)
Non-Oil Transfer Rev. p.c.	652	1,440	80	-0.03**	-0.05**	-0.07*	-3.69***	-6.60***	-8.99**
				(0.01)	(0.03)	(0.04)	(1.41)	(2.53)	(3.94)
Spending p.c.	1,165	1,392	83	-0.02	-0.10*	-0.23***	-3.45	-12.43**	-23.95***
				(0.03)	(0.06)	(0.08)	(2.42)	(4.89)	(6.23)
Investment p.c.	226	1,423	83	-0.17	-0.46**	-0.70**	-21.69*	-43.14***	-56.92***
				(0.15)	(0.21)	(0.28)	(12.09)	(12.11)	(12.18)
Personnel Spending p.c.	933	1,392	83	-0.04*	-0.14**	-0.26***	-4.92**	-15.64***	-26.42***
				(0.02)	(0.06)	(0.09)	(2.08)	(4.73)	(6.30)
Education Spending p.c.	571	1,392	83	-0.01	-0.14**	-0.25**	-2.93	-15.78***	-25.64***
				(0.04)	(0.06)	(0.10)	(3.87)	(5.47)	(7.26)
Health Spending p.c.	449	1,392	83	-0.09	-0.17**	-0.24*	-12.76*	-18.62***	-26.23***
				(0.08)	(0.08)	(0.12)	(7.38)	(6.47)	(9.10)
GDP per capita	22,362	1,162	83	0.00	-0.04	-0.12	-1.86	-8.14	-18.27
				(0.04)	(0.08)	(0.17)	(4.30)	(7.71)	(13.66)
Population	80,980	1,494	83	0.01	0.04	0.05	-0.09	2.16	0.87
				(0.01)	(0.04)	(0.08)	(1.34)	(3.99)	(7.66)
No. Firms Extractive	9.1	1,494	83	-0.12*	-0.28**	-0.20	-14.73**	-29.30***	-26.79*
				(0.07)	(0.13)	(0.22)	(6.14)	(9.32)	(15.92)
No. Firms Mfg.	165.2	1,494	83	-0.01	0.01	-0.19*	-2.38	-2.85	-21.26***
				(0.03)	(0.07)	(0.10)	(3.26)	(7.02)	(7.69)
Avg. Formal Wage (Monthly)	1,034	1,494	83	-0.01	-0.08**	-0.11**	-2.13	-8.88***	-12.42***
				(0.02)	(0.03)	(0.05)	(1.767)	(3.036)	(4.21)

Sample includes disappointed municipalities (received less than 40% of revenues expected from discovery by 2017) and wells controls. Regressions include municipality and year FEs; standard errors are clustered at municipality level. Continuous outcome variables use inverse hyperbolic sine transformation. Monetary variables are inverse hyperbolic sine-transformed constant 2010 BRL. To interpret semi-elasticities, I use the small sample bias correction proposed by Kennedy (1981):

$$\hat{P} = (e^{(\beta - \frac{\widehat{Var(\beta)}}{2})} - 1) \times 100$$

Appendices

Return

Coefficients and Elasticities (Satisfied)

	Sample Properties			Coefficients			Small-n Bias Correct. Elast.		
Outcomes	$\overline{X}$	**n**	**Units**	**1 Year**	**5 Years**	**10 Years**	**1 Year**	**5 Years**	**10 Years**
Total Revenue (Millions)	345	1,211	71	0.05	0.16*	0.65***	3.01	11.74	74.53**
				(0.04)	(0.09)	(0.20)	(4.62)	(10.43)	(34.21)
Revenue p.c.	2,361	1,211	71	0.05	0.16	0.66***	2.74	11.69	75.12**
				(0.04)	(0.10)	(0.20)	(4.54)	(10.91)	(34.60)
Tax Revenue p.c.	279	1,211	71	0.01	-0.06	-0.21	-3.23	-15.98	-30.32
				(0.09)	(0.23)	(0.30)	(8.68)	(19.50)	(20.58)
Oil Revenue p.c.	606	1,278	71	1.21***	2.10***	4.35***	170.90	490.53	5441.63
				(0.42)	(0.65)	(0.68)	(114.05)	(383.00)	(3755.01)
Non-Oil Transfer Rev. p.c.	691	1,224	68	-0.03	-0.01	0.04	-3.63**	-2.59	1.26
				(0.02)	(0.04)	(0.05)	(1.72)	(4.10)	(5.12)
Spending p.c.	1,264	1,211	71	-0.07	0.01**	0.25**	-9.00	-2.15	20.79
				(0.05)	(0.07)	(0.12)	(4.12)	(6.55)	(14.07)
Investment p.c.	263	1,230	71	-0.06	0.34	0.82	-21.73	11.98	59.35
				(0.37)	(0.46)	(0.71)	(29.22)	(51.91)	(113.07)
Personnel Spending p.c.	997	1,211	71	-0.04	0.01*	0.19*	-5.86	-2.56	14.32
				(0.03)	(0.07)	(0.11)	(3.23)	(6.87)	(12.83)
Education Spending p.c.	627	1,208	71	-0.01	0.03*	0.35	-4.62	0.07	28.02
				(0.07)	(0.07)	(0.20)	(6.40)	(6.61)	(26.10)
Health Spending p.c.	461	1,208	71	0.20**	0.11	0.34	17.62*	6.88	25.42
				(0.08)	(0.09)	(0.23)	(9.90)	(9.61)	(29.05)
GDP per capita	27,043	994	71	0.06	0.57**	1.42***	2.56	55.00	253.10**
				(0.08)	(0.27)	(0.31)	(7.75)	(42.12)	(110.29)
Population	155,964	1,278	71	0.00	-0.01	-0.01	-0.40	-1.63	-3.11
				(0.01)	(0.02)	(0.05)	(0.89)	(2.17)	(4.49)
No. Firms Extractive	17.5	1,278	71	0.09	0.07	0.30	2.59	-1.89	18.90
				(0.12)	(0.17)	(0.26)	(12.29)	(16.78)	(31.23)
No. Firms Mfg.	273.8	1,278	71	-0.09*	-0.12**	-0.23**	-10.76**	-13.70***	-25.03***
				(0.05)	(0.06)	(0.11)	(4.29)	(4.76)	(8.05)
Avg. Formal Wage	1,073	1,278	71	-0.03	-0.01*	-0.09**	-4.17	-3.84	-11.06**
				(0.02)	(0.05)	(0.05)	(1.94)	(4.72)	(4.66)

Sample includes satisfied municipalities (received more than 40% of revenues expected from discovery by 2017) and wells controls. Regressions include municipality and year FEs; standard errors are clustered at municipality level. Continuous outcome variables use inverse hyperbolic sine transformation. Monetary variables are inverse hyperbolic sine-transformed constant 2010 BRL. To interpret semi-elasticities, I use the small sample bias correction proposed by Kennedy (1981):

$$\hat{\beta} \Rightarrow (e^{(\beta - \frac{\widehat{Var(\beta)}}{2})} - 1) \times 100$$

Small Sample Bias Corrected Semi-Elasticities (Disappointed)

	TWFE Wells	TWFE Pre-Matching	CS Wells	CS Pre-Matching
Total Revenue (Millions)	-20.79***	-10.22*	-35.17	-19.67
	(6.02)	(5.97)	(*In Progress*)	
Revenue p.c.	-26.69***	-24.41***	-46.43	-37.29
	(8.02)	(7.42)		
Tax Revenue p.c.	-37.30***	-35.04***	-33.29	-34.26
	(14.28)	(11.62)		
Oil Revenue p.c.	-5.57	35.46	-32.16	-16.70
	(40.41)	(52.28)		
Transfer Revenue p.c.	-8.99**	-7.82**	-15.95	-16.57
	(3.94)	(3.36)		
Spending p.c.	-23.95***	-16.44***	-40.48	-27.50
	(6.23)	(6.20)		
Investment p.c.	-56.92***	-60.59***	-76.50	-70.49
	(12.18)	(10.43)		
Personnel Spending p.c.	-26.42***	-18.33***	-44.28	-30.34
	(6.30)	(6.45)		
Education Spending p.c.	-25.64***	-20.87***	-42.05	-32.29
	(7.26)	(6.89)		
Health Spending p.c.	-26.23***	-31.61***	-39.41	-34.77
	(9.10)	(7.23)		
# Extractive Firms	-26.79*	-7.07	-22.94	9.49
	(15.92)	(19.42)		
# Mfg. Firms	-21.26***	2.54	-13.50	16.11
	(7.69)	(8.73)		
Avg. Formal Wage	-12.42***	-4.22	-19.86	-5.03
	(4.21)	(3.66)		
GDP p.c.	-18.27	-18.08	-39.00	-15.06
	(13.66)	(12.37)		
Population	0.87	10.49	-38.89	-4.86
	(7.66)	(7.95)		
n (municipality-years)	1494	15570	1494	15570

To interpret semi-elasticities, I use the small sample bias correction proposed by Kennedy (1981):

$$\hat{P} = (e^{(\beta - \frac{\widehat{Var(\beta)}}{2})} - 1) \times 100$$

Small Sample Bias Corrected Semi-Elasticities (Satisfied)

Return

	TWFE Wells	TWFE Pre-Matching	CS Wells	CS Pre-Matching
Total Revenue (Millions)	74.53**	107.96***	89.59	111.36
	(34.21)	(39.71)	(*In Progress*)	
Revenue p.c.	75.12**	95.43**	84.06	106.03
	(34.60)	(37.66)		
Tax Revenue p.c.	-30.32	-5.31	-11.39	6.54
	(20.58)	(24.45)		
Oil Revenue p.c.	5441.63	6205.26	6679.58	5057.57
	(3755.01)	(4330.57)		
Transfer Revenue p.c.	1.26	5.40	1.95	1.24
	(5.12)	(5.15)		
Spending p.c.	20.79	37.82**	21.93	43.86
	(14.07)	(15.18)		
Investment p.c.	59.35	75.04	180.02	158.75
	(113.07)	(125.85)		
Personnel Spending p.c.	14.32	30.86**	22.15	53.77
	(12.83)	(13.64)		
Education Spending p.c.	28.02	36.55	33.62	48.37
	(26.10)	(25.93)		
Health Spending p.c.	25.42	23.31	38.15	28.69
	(29.05)	(23.63)		
# Extractive Firms	18.90	75.28*	23.16	110.61
	(31.23)	(42.32)		
# Mfg. Firms	-25.03***	-7.53	-21.45	-1.79
	(8.05)	(8.92)		
Avg. Formal Wage	-11.06**	-1.80	-10.12	10.10
	(4.66)	(4.38)		
GDP p.c.	253.10**	290.35**	275.49	330.81
	(110.29)	(116.96)		
Population	-3.11	3.94	272.29	-1.46
	(4.49)	(4.23)		
n (municipality-years)	1278	9012	1278	9012

To interpret semi-elasticities, I use the small sample bias correction proposed by Kennedy (1981):

$$\hat{P} = (e^{(\beta - \frac{\widehat{Var(\beta)}}{2})} - 1) \times 100$$

Patronage and Elected Politician Characteristics

Winner Characteristics	TWFE Wells	TWFE Pre-Match
Winners' Age	0.118	0.045
	(0.691)	(0.629)
Winner Share Female	0.011	0.008
	(0.018)	(0.018)
Winners' Avg. Schooling	-0.150*	-0.142*
	(0.089)	(0.076)
Patronage (Mayors Only)		
No. Donors Hired to Commissioned Posts	-0.013	-0.197
	(0.045)	(0.222)
Share of Donors Among Commissioned Hires	0.000	0.000
	(0.000)	(0.003)
Share of Commissioned Hires Among Donors	0.000	-0.007
	(0.001)	(0.005)
Patronage (All Politicians)		
No. Donors Hired to Commissioned Posts	-0.039	0.137
	(0.186)	(0.169)
Share of Donors Among Commissioned Hires	-0.002	-0.001
	(0.003)	(0.003)
Share of Commissioned Hires Among Donors	-0.011	-0.008
	(0.007)	(0.006)
Municipality FEs	Y	Y
Election Period FEs	Y	Y
n (municipality-election periods)	404	3,745