

Technical Appendix

Project name: Enhancing the effect of cash buyback on return of unused opioids

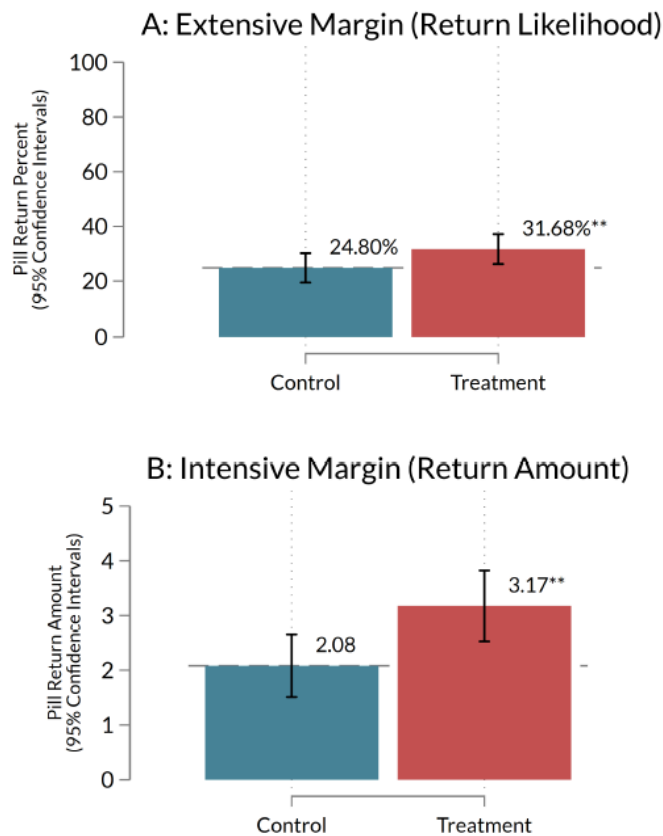
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Table A.1. Balance on select covariates: Cluster-level (n = 111)

	T Mean	C Mean	T Count	C Count	Adj. Difference	P-value
<i>Patient</i>						
Age	61.16	60.80			-0.20	0.88
Female (0/1)	0.10	0.08	21	22	-0.01	0.76
<i>Prescription</i>						
Morphine mg equiv.	89.03	85.13			6.65	0.43
Opioid acute (0/1)	0.02	0.03	4	6	0.00	0.98
<i>Service Group</i>						
General (0/1)	0.49	0.49	125	132	-0.05	0.40
Orthopedics (0/1)	0.21	0.15	57	34	0.10	0.03
Plastics (0/1)	0.14	0.16	39	40	0.00	0.96
Urology (0/1)	0.03	0.06	6	13	-0.02	0.28
<i>Joint Significance</i>						
F statistic: 1.371						
p-value: .219						

Figure A.2. A: Extensive Margin (Return Likelihood), B: Intensive Margin (Return Amount)



* Treatment effect estimation yields $p \leq 0.05$ (one-tailed)
 ** Treatment effect estimation yields $p \leq 0.05$ (two-tailed and one-tailed)

Table A.2. Primary treatment effect estimates

	(1) Extensive Likelihood	(2) Extensive Likelihood	(3) Extensive Likelihood	(4) Intensive Amount	(5) Intensive Amount	(6) Intensive Amount
Treatment	0.069 (0.040)	0.069 (0.028)	0.049 (0.030)	1.093 (0.493)	1.093 (0.327)	1.139 (0.385)
<i>N</i>	512	512	512	512	512	512
Control mean	0.248	0.248	0.248	2.081	2.081	2.081
Covariates	Yes	Yes	No	Yes	Yes	No
Block FEs	Yes	Yes	Yes	Yes	Yes	Yes
Clustered errors	No	Yes	Yes	No	Yes	Yes
Pre-registered	Yes	No	No	Yes	No	No

Table A.3. Covariate summary statistics

	N	Mean	SD	Min	Max
<i>Prescription</i>					
Pills prescribed ⁺	512	11.75	8.53	1	50
Opioid acute (0/1)	512	.02	.14	0	1
MME - 2nd quartile (0/1)	512	.18	.38	0	1
MME - 3rd quartile (0/1)	512	.26	.44	0	1
MME - 4th quartile (0/1)	512	.23	.42	0	1
<i>Patient</i>					
Female (0/1)	512	.08	.28	0	1
Ages 30-34 (0/1)	512	.05	.22	0	1
Ages 35-39 (0/1)	512	.05	.22	0	1
Ages 40-44 (0/1)	512	.05	.22	0	1
Ages 45-49 (0/1)	512	.05	.21	0	1
Ages 50-54 (0/1)	512	.06	.25	0	1
Ages 55-59 (0/1)	512	.11	.31	0	1
Ages 60-64 (0/1)	512	.12	.32	0	1
Ages 65-69 (0/1)	512	.12	.32	0	1
Ages 70-74 (0/1)	512	.21	.4	0	1
Ages 75-79 (0/1)	512	.1	.3	0	1
Ages 80-90 (0/1)	512	.07	.25	0	1
<i>Prescriber</i>					
Physician's assistant (0/1)	512	.29	.45	0	1
Resident physician (0/1)	512	.49	.5	0	1
<i>Procedure</i>					
Hemorrhoid (0/1)	512	.08	.27	0	1
Cholecystectomy (0/1)	512	.06	.25	0	1
Inguinal/femoral hernia (0/1)	512	.19	.4	0	1
Other hernia (0/1)	512	.07	.26	0	1
Knee cartilage excision (0/1)	512	.04	.19	0	1
Non-hip/knee arthroplasty (0/1)	512	.04	.2	0	1
Other muscle/tendon (0/1)	512	.11	.31	0	1
<i>Service Group</i>					
General (0/1)	512	.5	.5	0	1
Orthopedics (0/1)	512	.18	.38	0	1
Plastics (0/1)	512	.15	.36	0	1
Urology (0/1)	512	.04	.19	0	1

+ Included in the table for reference, but not used as a control.

Table A.4. Count of different prescriptions within procedures

	Codeine	Dilaudid	Oxycontin	Percocet	Tramadol	Vicodin
<i>Procedure</i>						
Other	1	4	169	8	12	11
Hemorrhoid	0	2	36	1	0	1
Cholecystectomy	0	0	33	0	0	0
Inguinal/femoral hernia	0	0	97	0	0	2
Other hernia	0	1	34	0	1	2
Knee cartilage excision	0	1	15	0	4	0
Non-hip/knee arthroplasty	0	2	17	0	1	2
Other muscle/tendon	0	3	45	1	4	2

Table A.5. Cluster-level covariate balance (n = 111)

	T Mean	C Mean	T Count	C Count	Adj Difference	P-value
<i>Prescription</i>						
Opioid acute (0/1)	0.018	0.029	4	6	0.000	0.982
Morphine mg equiv.	89.030	85.135			6.648	0.426
<i>Patient</i>						
Female (0/1)	0.098	0.079	21	22	-0.009	0.759
Age	61.157	60.796			-0.203	0.879
<i>Prescriber</i>						
Physician's assistant (0/1)	0.291	0.267	76	71	0.012	0.805
Resident physician (0/1)	0.478	0.500	128	125	-0.003	0.962
<i>Procedure</i>						
Hemorrhoid (0/1)	0.066	0.080	19	21	-0.017	0.520
Cholecystectomy (0/1)	0.074	0.068	14	19	-0.016	0.483
Inguinal/femoral hernia (0/1)	0.199	0.181	50	49	0.002	0.967
Other hernia (0/1)	0.056	0.089	17	21	-0.028	0.354
Knee cartilage excision (0/1)	0.065	0.013	17	3	0.059	0.003
Non-hip/knee arthroplasty (0/1)	0.031	0.051	9	13	-0.018	0.328
Other muscle/tendon (0/1)	0.133	0.087	34	21	0.064	0.029
<i>Service Group</i>						
General (0/1)	0.488	0.491	125	132	-0.047	0.399
Orthopedics (0/1)	0.210	0.146	57	34	0.097	0.028
Plastics (0/1)	0.142	0.164	39	40	0.002	0.965
Urology (0/1)	0.033	0.059	6	13	-0.017	0.280
<i>Joint Significance</i>						
F statistic: 2.103						
p-value: .012						

No individual differences (p-values above) are significant after Holm-Bonferroni adjustment (5% family-wise error rate).

Table A.6. Additional balance statistics

	SMD - patient	SMD - cluster	VR - patient	VR - cluster
<i>Prescription</i>				
Opioid acute (0/1)	0.06	0.12	1.23	1.26
Morphine mg equiv.	-0.13	-0.10	0.94	1.07
<i>Patient</i>				
Female (0/1)	0.02	-0.12	1.03	0.76
Age	-0.01	-0.04	1.14	1.19
<i>Prescriber</i>				
Physician's assistant (0/1)	0.03	-0.09	0.98	0.83
Resident physician (0/1)	0.01	0.07	1.00	0.85
<i>Procedure</i>				
Hemorrhoid (0/1)	0.03	0.11	1.05	1.04
Cholecystectomy (0/1)	0.08	-0.04	1.16	0.56
Inguinal/femoral hernia (0/1)	0.00	-0.08	1.00	0.88
Other hernia (0/1)	0.06	0.25	1.11	1.22
Knee cartilage excision (0/1)	0.28	-0.52	0.44	0.57
Non-hip/knee arthroplasty (0/1)	0.08	0.20	1.20	1.66
Other muscle/tendon (0/1)	0.16	-0.24	0.81	0.89
<i>Service Group</i>				
General (0/1)	0.07	0.01	1.00	0.97
Orthopedics (0/1)	0.23	-0.29	0.82	1.13
Plastics (0/1)	0.02	0.10	1.02	0.96
Urology (0/1)	0.15	0.22	1.46	1.24

SMDs: Control - Treatment. VRs: Control/Treatment.

Table A.7. Alternative CRVEs

	(1) Extensive Likelihood	(2) Extensive Likelihood	(3) Intensive Amount	(4) Intensive Amount
Treatment	0.069 (0.035)	0.049 (0.038)	1.093 (0.421)	1.139 (0.500)
Intercept	0.369 (0.358)	0.469 (0.367)	4.361 (4.458)	5.413 (4.240)
<i>N</i>	512	512	512	512
BRL p-value	0.029	0.101	0.006	0.014
Wild p-value	0.029	0.106	0.003	0.014
Covariates	Yes	No	Yes	No
Pre-registered	No	No	No	No

Coefficient estimates from OLS regressions.

Cluster-robust standard errors (BRL) are in parentheses.

One-sided p-values for treatment effects are in the footer.

Table A.8. 2SLS treatment effects

	(1) Extensive Likelihood	(2) Extensive Likelihood	(3) Intensive Amount	(4) Intensive Amount
Cards received (0,1,2)	0.040 (0.015)	0.028 (0.016)	0.628 (0.173)	0.650 (0.207)
<i>N</i>	512	512	512	512
2SLS p-value	0.004	0.040	0.000	0.001
Wild p-value	0.019	0.105	0.002	0.007
Covariates	Yes	No	Yes	No
Block FEs	Yes	Yes	Yes	Yes
Pre-registered	No	No	No	No

Coefficient estimates from 2SLS regressions.

Cluster-robust errors are in parentheses.

One-sided p-values for treatment effects are in the footer.

Table A.9. Covariate balance under randomization inference, cluster-level (n = 111)

	Adjusted difference	p-value
<i>Prescription</i>		
Opioid acute (0/1)	0.000	0.964
Morphine mg equiv.	6.648	0.395
<i>Patient</i>		
Female (0/1)	-0.009	0.745
Age	-0.203	0.868
<i>Prescriber</i>		
Physician's assistant (0/1)	0.012	0.798
Resident physician (0/1)	-0.003	0.960
<i>Procedure</i>		
Hemorrhoid (0/1)	-0.017	0.502
Cholecystectomy (0/1)	-0.016	0.451
Inguinal/femoral hernia (0/1)	0.002	0.968
Other hernia (0/1)	-0.028	0.327
Knee cartilage excision (0/1)	0.059	0.004*
Non-hip/knee arthroplasty (0/1)	-0.018	0.312
Other muscle/tendon (0/1)	0.064	0.026
<i>Service Group</i>		
General (0/1)	-0.047	0.371
Orthopedics (0/1)	0.097	0.026
Plastics (0/1)	0.002	0.964
Urology (0/1)	-0.017	0.283
<i>Joint Significance</i>		
F statistic: 2.102		
p-value: .023		

P-values for individual coefficients are compared to a simulated significance threshold of .0046.
Only one (*) is below this threshold and significant after adjusting for multiple testing.

Table A.10. Treatment effects under randomization inference

	Estimate	p-value
<i>Extensive margin (return likelihood)</i>		
Covariates and block FEs	0.069	0.076
Block FEs	0.049	0.221
<i>Intensive margin (return amount)</i>		
Covariates and block FEs	1.093	0.014
Block FEs	1.139	0.024

Table A.11. Mixture cure model results

Incidence Model	Latency Model	TR	p-value	CI lower	CI upper
Intercept-only	Treatment	1.133	0.057	1.000	1.279
Treatment	Treatment	1.133	0.050	1.006	1.279
Treatment and controls	Treatment and controls	1.157	0.160	1.004	1.373

Estimates, one-sided p-values, and 95% CIs. TR = time ratio.

Table A.12. Effect heterogeneity by pill type (reference category is Oxycontin)

	(1) Extensive Likelihood	(2) Intensive Amount	(3) Extensive Likelihood	(4) Intensive Amount
Treatment	0.065 (0.030)	0.834 (0.371)		
Treatment x Other Opioid	-0.001 (0.081)	2.202 (1.424)		
Cards received			0.031 (0.016)	0.437 (0.201)
Cards received x Other Opioid			0.055 (0.060)	1.619 (0.862)
<i>N</i>	512	512	512	512
One-sided p-value: treatment	0.016	0.013	0.031	0.015
One-sided p-value: interaction	0.494	0.063	0.181	0.030
Control mean (Oxycontin)	0.254	2.141	0.254	2.141
Control mean (Other)	0.200	1.633	0.200	1.633
OLS	Yes	Yes	No	No
2SLS	No	No	Yes	Yes

Table A.13. ITT heterogeneity based on pandemic timing

	(1) Extensive Likelihood	(2) Extensive Likelihood	(3) Intensive Amount	(4) Intensive Amount
Treatment	0.039 (0.062)	0.047 (0.048)	1.424 (0.710)	1.105 (0.581)
Treatment x Post-PHE	0.037 (0.073)		-0.449 (0.806)	
Treatment x Post-Lockdown		0.042 (0.063)		0.033 (0.726)
<i>N</i>	512	512	512	512
One-sided p-value: treatment	0.266	0.164	0.024	0.030
One-sided p-value: interaction	0.308	0.253	0.289	0.482
Covid PHE	Yes	No	Yes	No
Lockdown	No	Yes	No	Yes
OLS	Yes	Yes	Yes	Yes
2SLS	No	No	No	No

Table A.14. Intensive margin effects by differential return rate assumptions

	Estimate	CR1 p-value	Wild p-value
<i>No Block FEs</i>			
Compliers return as many	2.196	0.024	0.025
Compliers return 5% fewer	2.286	0.020	0.015
Compliers return 15% fewer	2.471	0.014	0.022
Compliers return 25% fewer	2.662	0.010	0.009
Compliers return 50% fewer	3.172	0.004	0.004
<i>Block FEs</i>			
Compliers return as many	2.362	0.035	0.069
Compliers return 5% fewer	2.456	0.030	0.059
Compliers return 15% fewer	2.648	0.023	0.044
Compliers return 25% fewer	2.847	0.017	0.050
Compliers return 50% fewer	3.378	0.007	0.019

All p-values reported are one-sided.

Table A.15. Treatment effects on the percent of pills returned

	(1) % return OLS	(2) % return OLS	(3) % return OLS	(4) % return 2SLS	(5) % return 2SLS	(6) % return 2SLS
Treatment assignment	6.095 (2.476)	4.490 (2.584)	6.095 (3.650)			
Cards received (0,1,2)				3.504 (1.305)	2.563 (1.393)	3.504 (1.923)
<i>N</i>	512	512	512	512	512	512
p-value	0.008	0.043	0.048	0.004	0.033	0.002
Control mean	21.977	21.977	21.977	21.977	21.977	21.977
Covariates	Yes	No	Yes	Yes	No	Yes
Clustered errors	Yes	Yes	No	Yes	Yes	No
Block FEs	Yes	Yes	Yes	Yes	Yes	Yes
Pre-registered	No	No	Yes	No	No	Yes

Coefficient estimates from OLS and 2SLS regressions.

Cluster-robust errors are in parentheses.

One-sided p-values for treatment effects are in the footer.

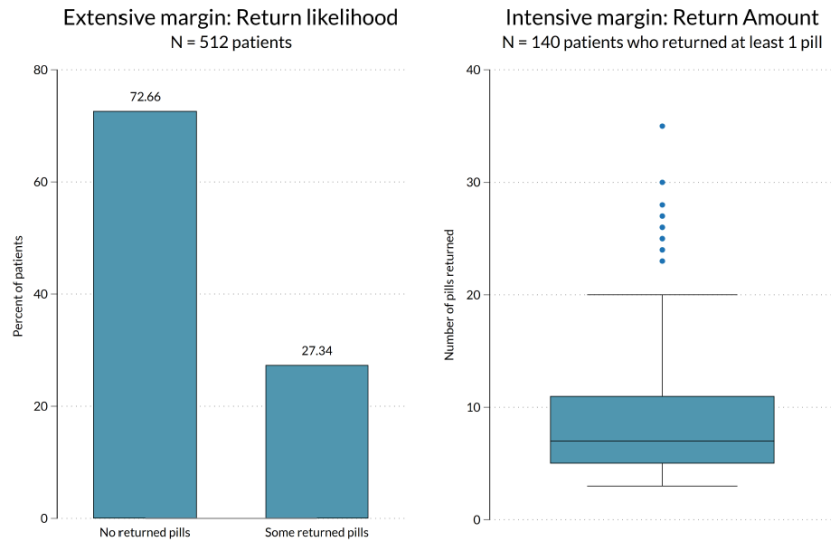
Figure A.3. Extensive margin, Intensive margin

Figure A.4. Covariates and pill return

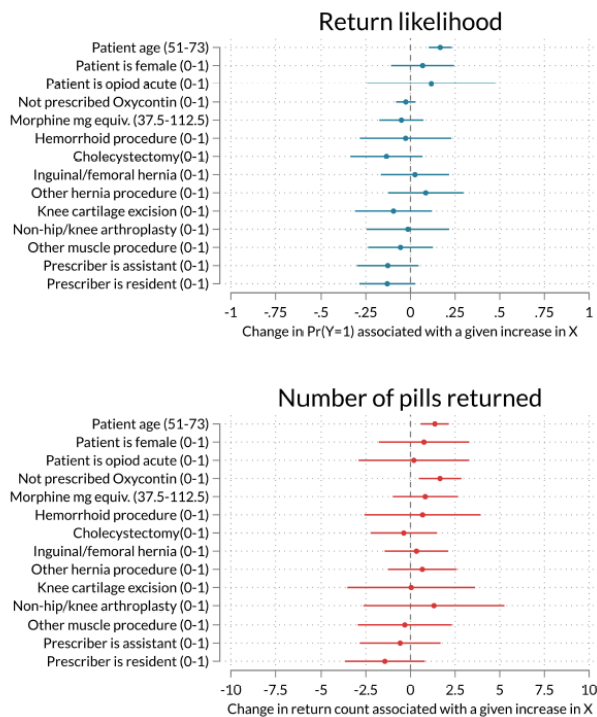


Figure A.5. Treatment effect heterogeneity

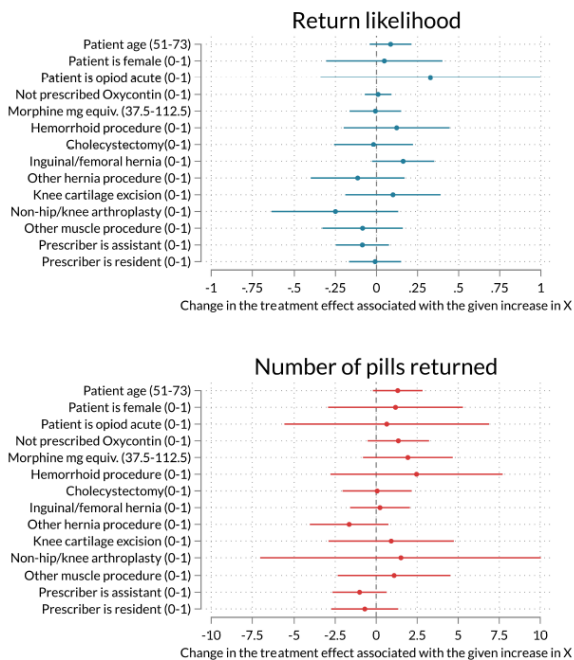


Figure A.6. Kaplan-Meier Survival Curve

