Refining the Valuation of Seasoned Equity Offerings by Creating a More Accurate Replicated Portfolio Using Machine Learning Techniques

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Motivation

- SEO abnormal returns show different results on different time horizons (Eckbo, 1995; Brealey, 2000)

- Using different matching methods different results were received on the same data

- Synthetic difference-in-difference approach shows high efficiency (Arkhangelsky, 2021).

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Literature review

Previous techniques in matching for SEO

Size matching by Ritter (2003):
Same market capitalization
SEO abnormal return -4.6% per year

Style matching by Ritter (2003):
Same size decile,
Closest Book to Market ratio
SEO abnormal return -0.9% per year

Combined by Huang (2014):
Same SIC code,
Same size-decile,
Same B/M quantile,
Closest 6-month stock returns to SEO
SEO abnormal return -18% per year

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Table 1
Mean percentage returns on SEOs from 1970–2000 during the first five years after issuing[a]

	1st 6 months	2nd 6 months	1st yr	2nd yr	3rd yr	4th yr	5th yr	Geometric mean yrs 1–5
SEO firms	6.7%	1.5%	9.4%	3.6%	10.9%	14.7%	15.9%	10.8%
Size-matched	6.1%	7.0%	14.0%	12.9%	14.4%	15.3%	15.5%	14.4%
Difference	0.6%	−5.5%	−4.6%	−9.3%	−3.5%	−0.6%	0.4%	−3.6%
Number	7502	7475	7504	7226	6603	5936	5188	7760
SEO firms	7.4%	2.2%	10.6%	5.3%	12.3%	14.2%	14.2%	11.3%
Style-matched	5.4%	5.6%	11.5%	13.6%	15.6%	16.9%	15.9%	14.7%
Difference	2.0%	−3.4%	−0.9%	−8.3%	−3.3%	−2.7%	−1.7%	−3.4%
Number	6638	6622	6638	6289	5711	5123	4448	6638

Ritter, 2003

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Methodology (Lasso regression)

Example: COHU (semiconducter equipment) with SEO in 2021 equals 15.56% in stock number increase

COHU Historical monthly returns

29.01.2016	29.02.2016	31.03.2016	29.04.2016	31.05.2016	30.06.2016	29.07.2016	31.08.2016	30.09.2016
0.003314	-0.052947	0.041192	-0.045417	0.020761	-0.086754	-0.026728	0.035117	0.051971

Real COHU annual returns

Return 2016	Return 2017	Return 2018	Return 2019	Return 2020	Return 2021	Return 2022	Return 2023
0.175779	0.599546	-0.259776	0.442785	0.687356	-0.002357	-0.158572	0.104212

$$\min_{\beta \in \mathbb{R}^p} \left\{ \frac{1}{N} \| y - X\beta \|_2^2 + \lambda \| \beta \|_1 \right\}$$

→ Beta (weights vector) →

ACLS
AMAT
AMKR
AVGO
CRUS
ENPH
FORM
FSLR
INTC
KLAC
LRCX
LSCC
MPWR
MTSI
MU
MXL
NVDA
OLED
ON
ONTO
PDFS
PLAB
POWI
QCOM
QRVO
RMBS
SLAB
SMTC
SWKS
SYNA
TER
TXN

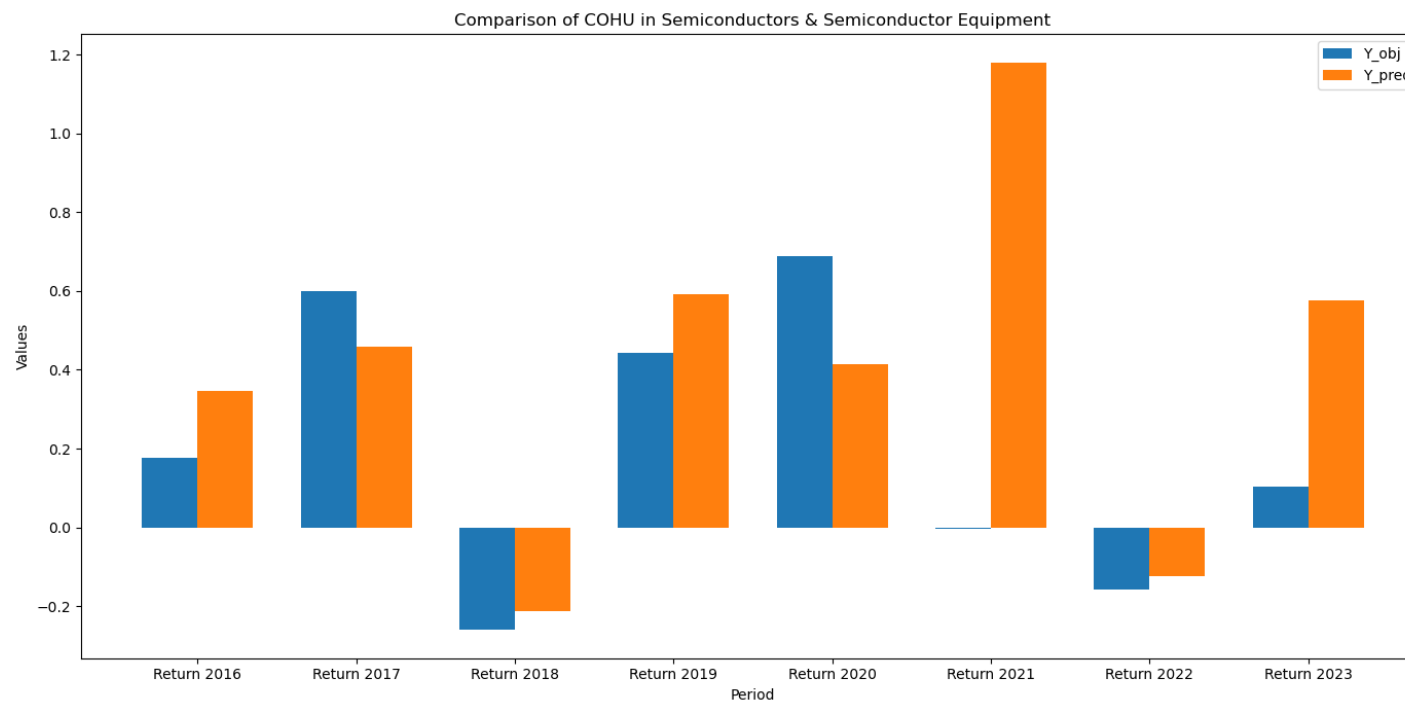Matrix of Non-SEO companies from the same industry for synthetic portfolio

Regularization coefficient found seperately using validation set

-

Synthetic portfolio returns x Beta

=

SEO abnormal return!

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Methodology (vizualisation)

Comparison of COHU in Semiconductors & Semiconductor Equipment

Number of used stocks: 11
ACLS with weight: 0.17659900337974774
AMKR with weight: 0.07180265443594944
ENPH with weight: 0.012100401149035855
FSLR with weight: 0.027215538764253182
MTSI with weight: 0.0661314673219442
MXL with weight: 0.018796856284767502
ON with weight: 0.4420594396770286
ONTO with weight: 0.17514026788999465
PLAB with weight: 0.03143959660229026
RMBS with weight: 0.0045285148705606825
SYNA with weight: 0.05779891048499768
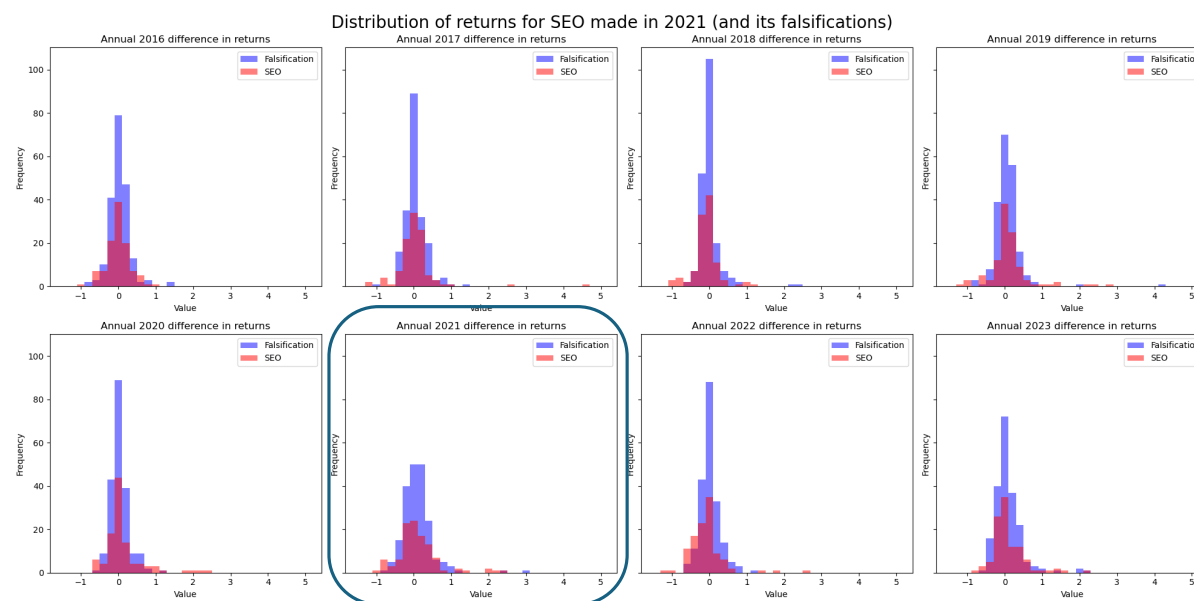
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Results

- SEO aggregated mean abnormal return over synthetic portfolio was 15% in 2021, -3% in 2022, 27% in 2023 (full abnormal return on common stock for SEO made respectively in 2021, 2022, 2023)

- Average full return on stocks equals 31.5%. Abnormal result is high in 2021 and 2023, low in 2022

- How confident are these results? Falsification (Young, 2019).

Abnormal returns in a year for SEO made the same year
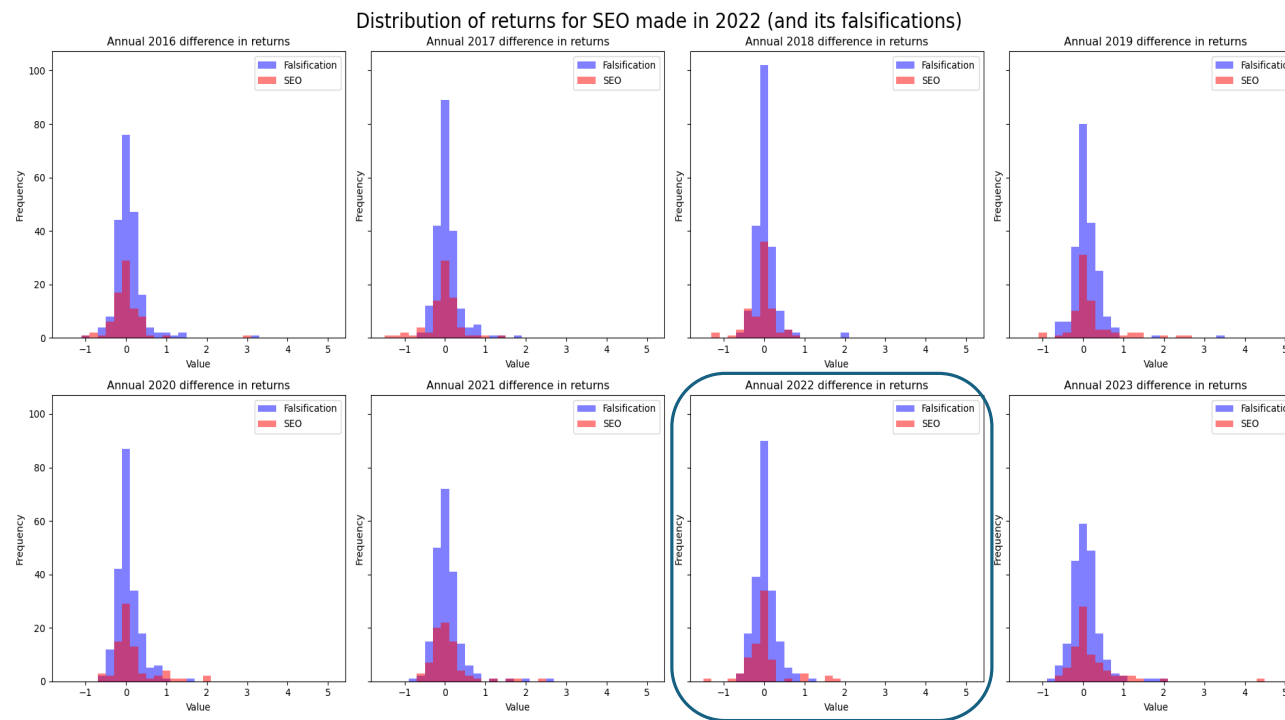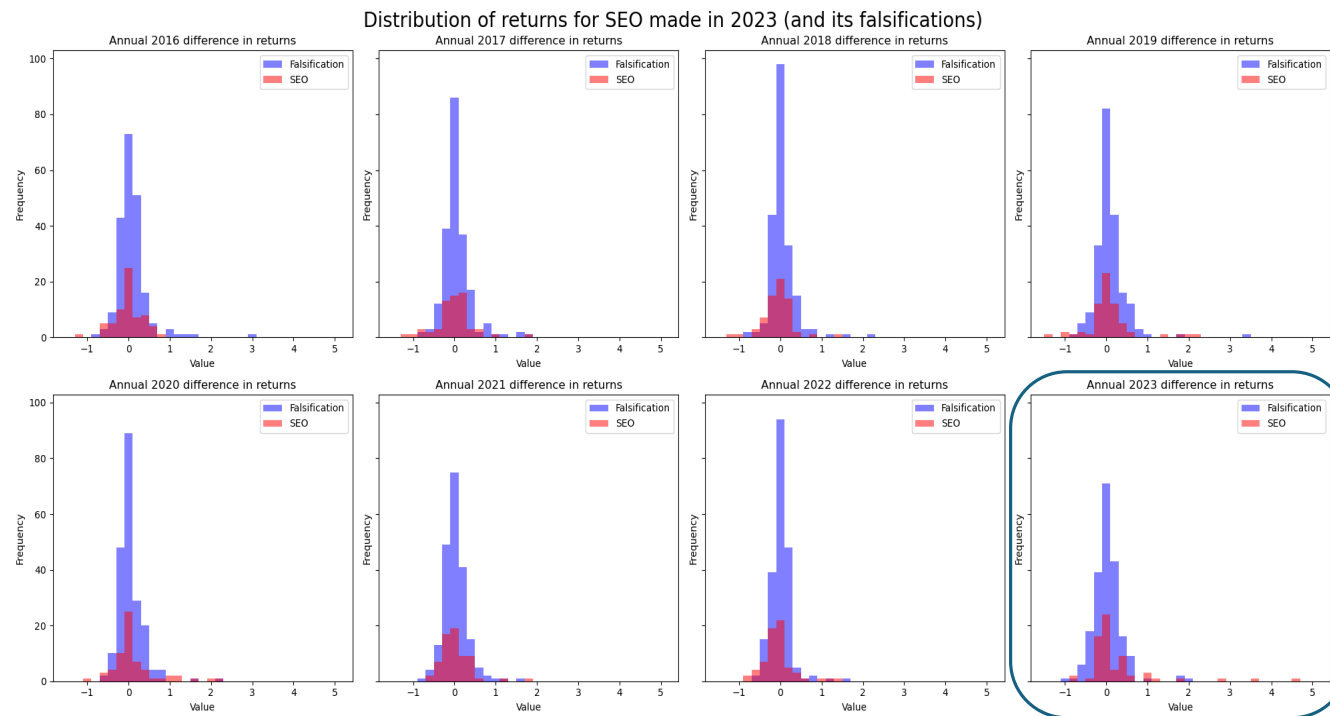

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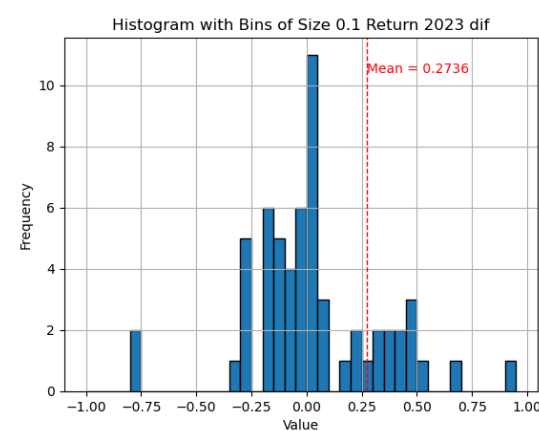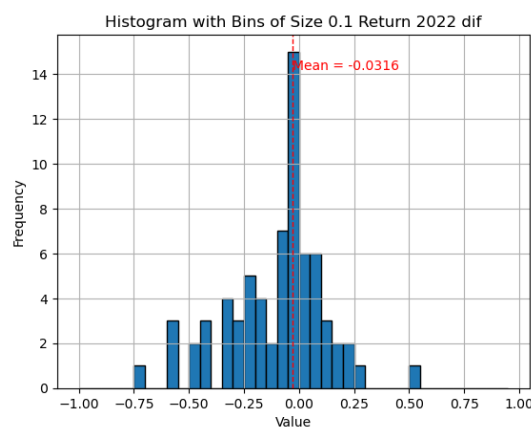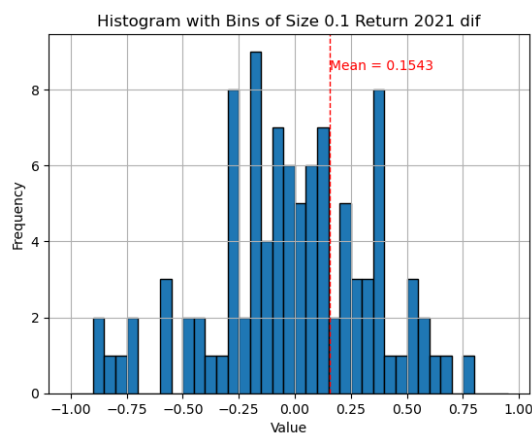
Falsification

- Assign treatment (SEO) randomly through all companies which did not make SEO in years 2020-2023
- Apply the same regression as before
- Check how predictions were made in the following SEO year (abnormal returns differ from 0).


Distribution of returns for SEO made in 2021 (and its falsifications)

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Falsification comparison (2022)

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Falsification comparison (2023)

Distribution of returns for SEO made in 2023 (and its falsifications)

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Falsification test

- With 10 rounds of random treatment assignment we get 0 as a mean average error

Histogram with Bins of Size 0.1 Falsification difference in returns for only non-SEO firms (with randomly assigned SEO in 2023)

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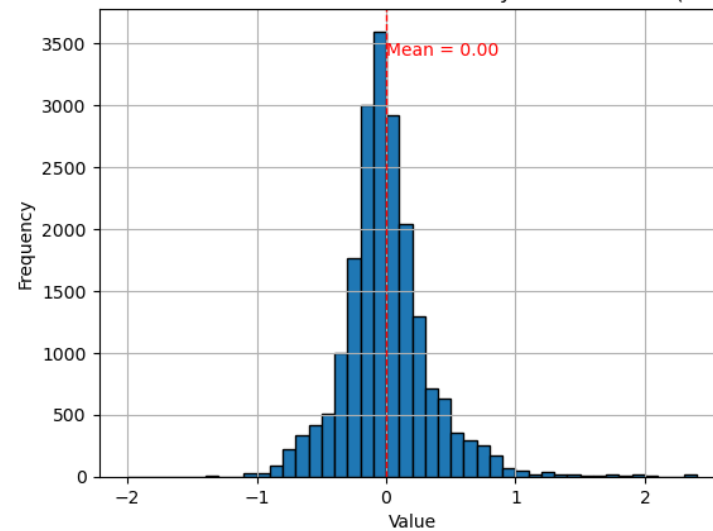
Impact

- SEO abnormal returns were positive two out of three observed years, which goes contrary to the previous research (where it was always negative)

- Falsification tests show that falsification results have close abnormal returns to the real SEO

- SEO abnormal returns goes much in line with falsification abnormal returns which means that solely SEO does not have any significant effect.

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Future research

- Check stability of the result on the longer periods

- Check aggregated returns on the longer periods

- With more detailed data make a more accurate returns check

- Make the same test on the previous data to check how it compares with the previous results (1990s, 2008 etc.).

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Conclusion

- SEO does not have a significant effect on the stock returns 1 year after issuance

- The likely effect is due to matching error.

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Q&A

- Novel result?

Applied new approach in making synthetic control for SEO

- Do weights up to 1?

No. Weights may be any positive numbers. Leverage can be used to finance replicating portfolio (synthetic controls) to get real returns which exceed 1.

- Why the sign changes?

In 2020 and 2021 all three highest abnormal returns had "Software" GICS Industry companies. They are all crypto mining companies. For them it was essential to raise new capital through SEO to finance increasing operational expenses. On the other hand, stock prices of these companies and full returns grew up very quickly driven by incredibly fast-growing crypto-assets prices. Other "Software" companies were not connected directly to crypto, hence they could not grow so fast. This effect was captured by abnormal returns. It would not exist if GICS Industry counted crypto projects as a separate industry.

- Is the model wrong?

Mean average errors on the training datasets for all years (except 2020, read the previous answer) have mean close to zero while on average full returns equal 31.5% annually. Mean absolute errors differ from year to year but for all training years did not exceed 10%. In-month errors compensate each other.

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Appendix
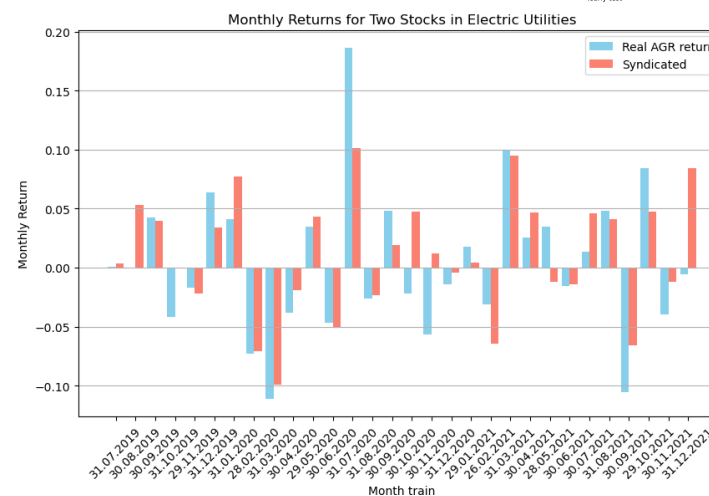
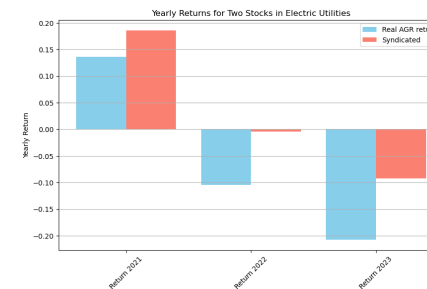## Refinitiv Workspace Data sample

016	29.07.2016	31.08.2016	30.09.2016	...	GICS Industry Name	Exchange Ticker	Difference in 4 years	Difference 2021-2020	Difference 2022-2021	Difference 2023-2022	Return 2020	Return 2021	Return 2022	Return 2023
029	-0.005563	0.113292	-0.048718	...	Mortgage Real Estate Investment Trusts (REITs)	ABR	0.530309	0.228777	0.17751	0.057649	0.117601	0.394183	-0.20693	0.30169
237	0.05141	-0.053825	0.041788	...	Retail REITs	ADC	0.674723	0.187663	0.264965	0.114734	0.021652	0.112609	0.034807	-0.070914
801	0.126942	-0.013331	0.024642	...	Semiconductors & Semiconductor Equipment	ADI	0.343118	0.421792	-0.030523	-0.025593	0.252636	0.209752	-0.049222	0.233547
767	0.319328	-0.272611	0.269702	...	Biotechnology	ADMA	1.154974	0.86662	0.132795	0.019142	-0.504447	-0.276923	1.751773	0.164948
579	-0.019974	-0.078423	0.007524	...	Electric Utilities	AGR	0.252031	0.251404	0.000145	0.000356	-0.071828	0.136403	-0.104832	-0.207511
...	...	...	...	...			...	...	...	...	...	...	...	...
813	-0.046967	0.035557	0.005919	...	Commercial Services & Supplies	VSEC	0.425316	0.151209	0.007068	0.229414	0.038687	0.595446	-0.223486	0.388626
552	-0.043893	0.225549	0.032826	...	Oil, Gas & Consumable Fuels	VTLE	1.946179	0.420489	-0.018296	1.112712	-0.643116	2.052284	-0.144853	-0.115325
462	0.630486	-0.291465	-0.033316	...	Metals & Mining	X	0.248157	0.220059	0.010608	0.012292	0.557146	0.42443	0.061217	0.956975
586	0.127951	0.208643	0.014104	...	Ground Transportation	XPO	0.137255	0.127451	0.0	0.008696	0.481481	0.1165	-0.276352	1.63112
342	-0.156742	-0.061546	0.111111	...	Energy Equipment & Services	XPRO	1.97343	1.876591	0.009236	0.024205	-0.438525	-0.127129	0.263415	-0.121897

The 52 weeks total return incorporates the price change and any relevant dividends for the last 52 weeks.
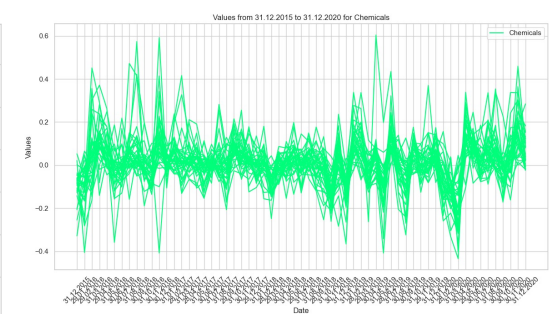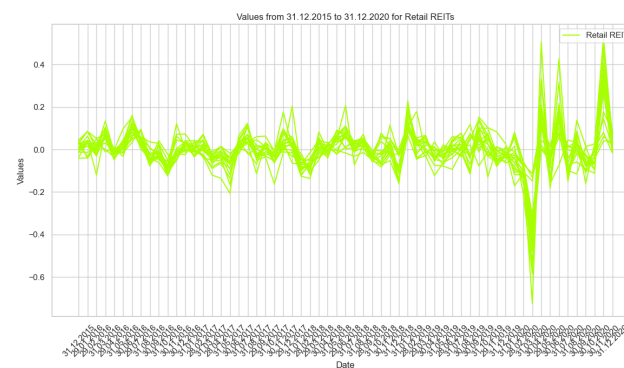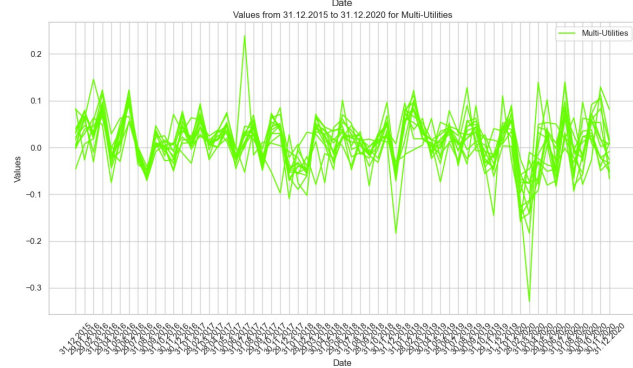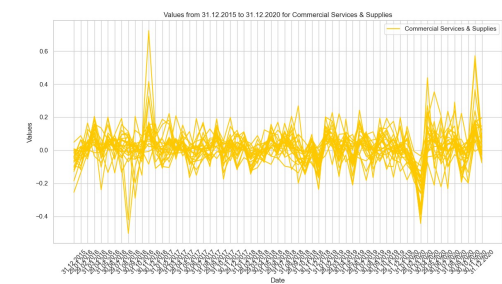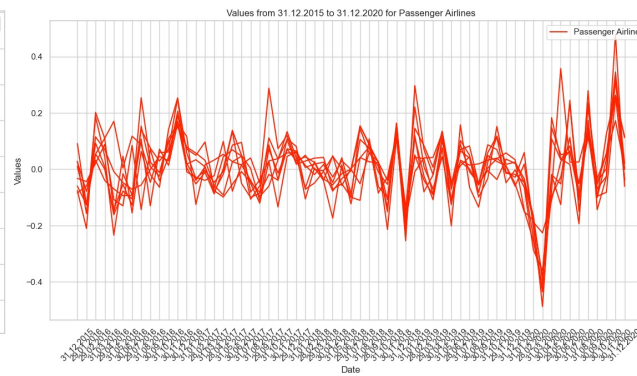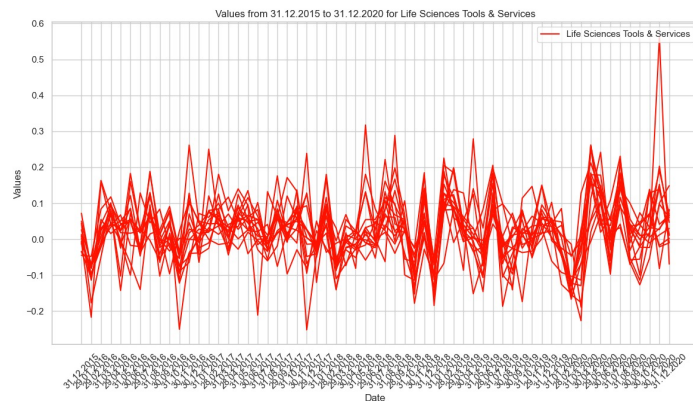
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Result for each SEO-made stock

```
Mean Squared Error: 0.8998319783356502
Number of used stocks: 6
ARWR with weight: 0.1819394761303203
BMRN with weight: 0.9584714386133741
BPMC with weight: 0.25237618576004806
CPRX with weight: 0.21162185316681736
IRWD with weight: 0.03224016956597153
TGTX with weight: 0.01015219013861003
```


Yearly Returns for Two Stocks in Electric Utilities

Monthly Returns for Two Stocks in Electric Utilities
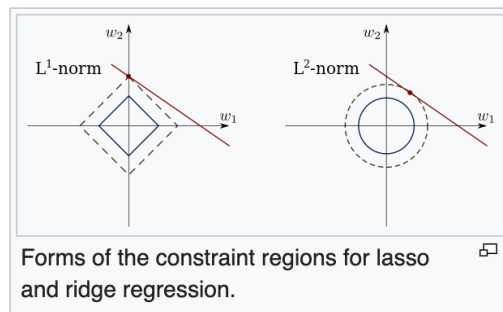
Appendix

Appendix

Least squares [edit]

Consider a sample consisting of N cases, each of which consists of p covariates and a single outcome. Let y_i be the outcome and $x_i := (x_1, x_2, \ldots, x_p)_i^T$ be the covariate vector for the ith case. Then the objective of lasso is to solve

$$\min_{\beta_0, \beta} \left\{ \sum_{i=1}^{N} \left(y_i - \beta_0 - x_i^T \beta \right)^2 \right\} \text{ subject to } \sum_{j=1}^{p} |\beta_j| \leq t.$$

in the so-called Lagrangian form

$$\min_{\beta \in \mathbb{R}^p} \left\{ \frac{1}{N} \|y - X\beta\|_2^2 + \lambda \|\beta\|_1 \right\}$$

where the exact relationship between t and λ is data dependent.

Forms of the constraint regions for lasso and ridge regression.

This controling approach absorbs different market conditions

All stocks are divided into two groups. SEO (Y) and non-SEO (X)
SEO issued stocks (Y) number difference 2020-2023 exceed 10%
In X all stock number doesn't exceed this benchmark
Drop outliers with dilution >400%, or buyback >50% (-60 firms). Drop values with empty cells (-490 firms). 1385 rows in clean data
Taking in syndicated portfolios companies with the same GICS Industry ticker, 2016-2020 monthly returns, only positive weights in the regression, no intercept, Lasso regularization

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Appendix

| Study	Horizon, weighting[b]	Sample size	Sample period	Mean buy-and-hold return		Annualized difference
				SEOs	Matching	
USA data						
Mitchell & Stafford[c]	3 yr (EW)	4439	1961–1993	34.8%	45.0%	−2.7%
Eckbo, Masulis & Norli[d]	5 yr (EW)	3315	1964–1995	44.3%	67.5%	−4.8%
Jegadeesh[e]	5 yr (EW)	2992	1970–1993	59.4%	93.6%	−4.9%
Spiess & Affleck-Graves[f]	5 yr (EW)	1247	1975–1989	55.7%	98.1%	−6.1%
Brav, Geczy & Gompers[g]	5 yr (EW)	3775	1975–1992	57.6%	83.9%	−3.9%
Mitchell & Stafford[c]	3 yr (VW)	4439	1961–1993	41.1%	45.3%	−1.1%
Eckbo, Masulis & Norli[d]	5 yr (VW)	3315	1964–1995	51.6%	62.2%	−2.2%
Brav, Geczy & Gompers[g]	5 yr (VW)	3775	1975–1992	72.5%	97.5%	−3.4%
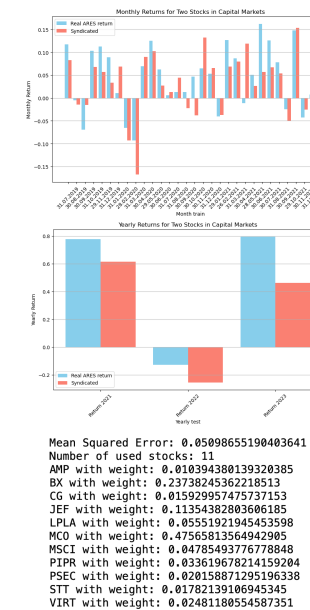
Figure 2: Previous aggregated results by Ritter (2003)

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