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The Methodology Matters: What Influences Market Reaction, and Post-Issue Returns in Seasoned Equity Offerings?

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Abstract: Using a large database of U.S. seasoned equity offering (SEO) announcements from 2010 to 2015, we examine the effects of several explanatory variables—firm specific, macroeconomic, fixed income, and stock market variables—on the announcement period abnormal stock returns and on the longer-run post-issue abnormal returns. We use five different statistical methods—multivariate linear regression, regression on a reduced model using principal components analysis, year-by-year regression on a reduced model using principal components analysis, random forest regression on the whole sample, and year-by-year random forest regression. In general, across the methods, we find that firm's profitability in the recent past is an important explanatory factor in both short-term and long-term abnormal stock returns, but several other significant explanatory factors change based on the statistical method used. Therefore, the statistical method used affects the results reported.

Keywords: seasoned equity offerings; SEO; announcement period abnormal stock returns; long-run post-issue abnormal returns; principal components analysis; random forest regression; key determinants

JEL Classification: G14

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1. Introduction

In this paper, we examine the determinants of the announcement period abnormal stock returns and post-issue abnormal stock returns in seasoned equity offerings, which include firm specific, macroeconomic, fixed income, and stock market variables. We use several different statistical methods to examine the significant explanatory variables and come to the conclusion that the statistical method used in research can influence the findings.

Previous studies have, generally, reported negative short-term or announcement period abnormal stock returns around SEO (Shahid et al. 2010; Masulis and Korwar 1986), presumably because of the negative effects on new equity on stock prices stemming from asymmetric information and dilution. Deshmukh et al. (2017) argues for the presence of informed short selling around SEO announcements. Gerard and Nanda (1993) find that informed traders acting strategically may try to manipulate offering prices by selling shares prior to SEO and profit from lower prices in the offering. Research on post-issue longer-term abnormal stock performance post-issue has found SEOs that are more overvalued prior to the announcement day experience a significantly larger decline over the subsequent five years (Purnanandam and Swaminathan 2006). Spiess and Affleck-Graves (1995) have also shown persistent stock underperformance in the three years post issue, when controlling for variables such as the trading system, firm's financials, and age. Asad et al. (2020) find that firms that are ex ante overlevered and overvalued were more likely to announce a seasoned equity offering. Perhaps as a result, Botta and Colombo (2019) find that both shareholders and bondholders experience negative returns following SEOs. From the

perspective of a firm's earnings and expenditure management, Xiang (2022) argues that the firms with high R&D spending experience stock overpricing and negative market reaction when they announce SEOs. Prior research has also used several explanatory variables—for example, past growth rate of firms (Purnanandam and Swaminathan 2006), or externalities such as hedge fund variables (Hull et al. 2018). Previous research have usually used linear regression to explain abnormal stock returns (e.g., Deshmukh et al. 2017), or two sample t-tests of difference in mean abnormal returns, or test of differences of median abnormal returns.

We use several groups of explanatory variables—firm financial variables, stock market variables, fixed income, and macroeconomic variables—to explain several measures of announcement period and long-run post-SEO abnormal returns, after controlling for time and industry fixed effects, and offer size.

Using a comprehensive sample of 2139 SEO announcements between 2010 and 2015, we first examine sample descriptive statistics and abnormal returns over different periods, and over and above different benchmarks. The results are consistent with the previous papers in the terms of announcement period abnormal returns around SEO announcements and post-issue longer-term abnormal returns, particularly longer-run post-issue underperformance. We propose the following hypothesis in the null form, to be tested in this paper:

> *The significant variables that explain announcement period abnormal returns and longer-run post-issue abnormal returns depend on the statistical method used.*

To test this hypothesis, we compare and contrast results using several different methods including panel regression, regression using principal components, random forest regression, and year-by-year regression. Across all the methods we use, we find that there are factors such as firm profitability of the immediate past, as measured, for example, by the return on assets, that significantly affect abnormal returns, but different statistical methods also yield different significant explanatory variables for short-term and longer-term returns. In conclusion, this research shows that results presented in empirical studies can depend on the statistical method used.

The next section describes our data and the variables we used. Section 3 reports the descriptive statistics. Section 4 reports on the analyses and the results, while Section 5 concludes.

2. Data and Variables

2.1. Data

Our initial data sample consisted of 3755 seasoned equity offering (SEO) announcements over a 5-year period from 2010 to 2015 collected from Refinitiv's Securities Data Company's (SDC) Platinum Global Public Issues database. For each firm making the SEO announcement, we used firm data (taken from the COMPUSTAT database), stock returns and market return data (taken from the Center for Research in Security Prices—CRSP database), and economy-wide and fixed income data (taken from the Federal Reserve database, FRED). After excluding observations for which we could not find all the available data, our final sample contained 2138 SEO announcements.

We normalized all explanatory variables by using their z-scores. Following Altman (2018), the original value, x, was converted as

$$x_a = \frac{x - \overline{x}}{\sigma_x}$$

where x_a is the transformed variable that would be used in regressions, $\overline{x}$ is the mean value, and σ_x is the standard deviation.

2.2. Variables

We calculated announcement periods' abnormal returns in several different ways based on various benchmark returns. We used S&P 500 index returns, equal-weighted index, or the value-weighted index published by the Center for Research in Security Prices (CRSP) as alternative benchmarks to calculate the abnormal returns. As suggested by Aggarwal and Rivoli (1990) and Durukan (2002), we defined short-term abnormal returns as each stock's 3-day, 7-day, or 21-day cumulative abnormal return (CAR) around the SEO announcement over and above equity beta times the corresponding benchmark return. The beta, β, was estimated by monthly returns in the pre-announcement period over the 3 years prior to the SEO announcement. For long-term abnormal returns, we followed Barber and Lyon (1997) to compute long-term CAR. The cumulative abnormal return (CAR) was calculated as

$$CAR_i = R_{firm} - \beta * R_{benchmark}$$

We subtracted equity beta (β) times the monthly returns of a benchmark from the monthly returns of the firm, and took the sum. We calculated CAR for SEO firms over 6 months and 12 months, post-issue.

For examining the various factors that could be related with the announcement period and post-announcement abnormal returns, we divided them into three different groups. These are: the firm variables (Group A), economy-wide and fixed income variables (Group B), and market variables (Group C). For the firm variables, following Nassar (2016), we computed financial ratios that included the return on asset (ROA), the return on equity (ROE), as at one, two, and four quarters before the SEO announcement, as proxies of the firm's financial performances. Following Mohanram (2003), we calculated the book-to-market ratio (BTM) as a measure of the growth options of the firm. Following Erawati and Widayanto (2016), we computed the operating income to total asset (OI/A) ratio as a proxy of firm's operating profits. For the group of economic and fixed income indices, following Daniell et al. (2010), we used the gross domestic product (GDP) index, consumer price index (CPI), and the GDP growth for the year before the SEO announcement as proxies of economic trend. Following Angbazo (1997), we used the short- and long-term rate of US government treasury as proxies for cost of funds. For the group of stock market variables, we calculated the stock index return in 3 months, 6 months, and 12 months before the SEO announcement. We standardized all our variables using "z" scores by subtracting the mean of a variable and dividing the result with the standard deviation, to convert all data to the same scale.

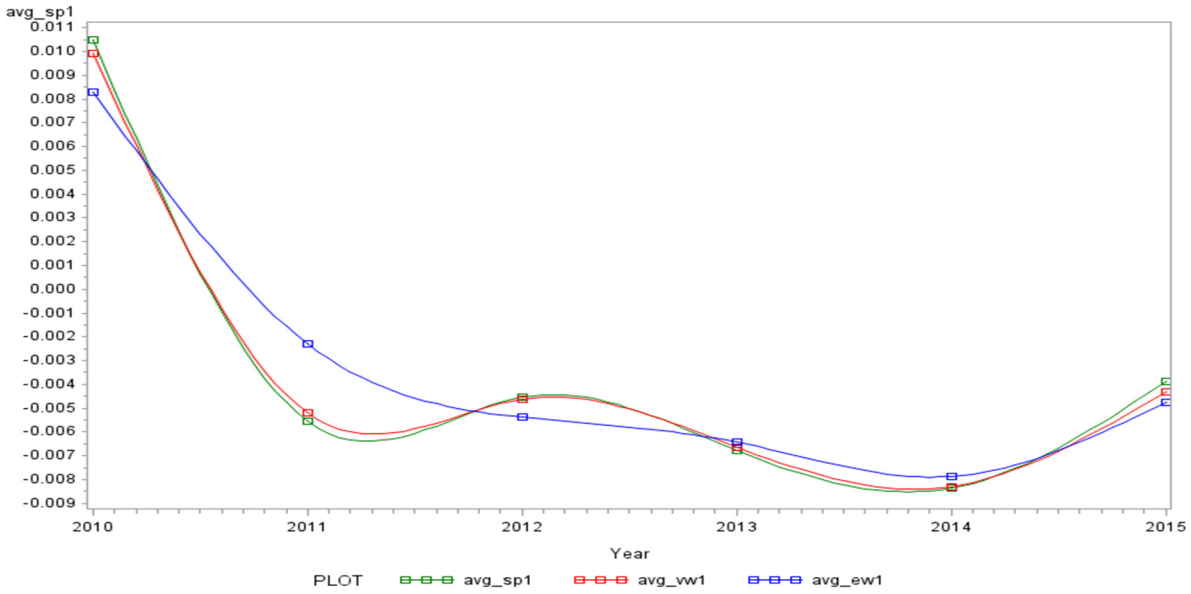
We also used the following control variables in our analyses. Following Islam et al. (2010), we used year and industry dummy variables, as the trends in the levels of underpricing and overpricing for SEOs could depend on time and industry. We also controlled for offer size, on which the underpricing may depend (see Corwin 2003); and underpricing and overpricing of an issue can affect announcement period returns and longer-term returns.

3. Descriptive Statistics

The three panels of Figure 1 show the year-by-year time-series plots of the average announcement period abnormal returns around the announcement: 1 day before to 1 day after, 3 days before to 3 days after, and 10 days before to 10 days after. Plots in green, red, and blue show the abnormal return over and above the S&P 500 index, CRSP value-weighted index, and CRSP equal-weighted index, respectively. The plots show that the abnormal return is volatile year to year, but generally negative for 3-day and 7-day abnormal returns and generally positive for the 21-day returns (also see Henry and Koski 2010). Hibbert et al. (2020) suggest that differences in beliefs in the market are a determinant of the volatility of short-term announcement period returns around SEO, which is what we also noticed. However, in line with Malladi and Fabozzi (2017), the equally weighted CRSP-adjusted abnormal returns were less volatile than the other abnormal returns. On average, the 3-day and 7-day abnormal returns, except in 2010 for the 3-day abnormal return, were negative, while the 21-day abnormal returns were all positive except 2010. The positive returns were

more in 2015. Our data indicate that the 21-day abnormal return was 0.14% higher than the 3-day abnormal return and 0.85% higher than the 7-day abnormal return, on average, of three different benchmarks. This result may imply a short selling around the time of the announcement and there is an overreaction immediately at the announcement.

This figure shows the time series plots of annual average announcement period abnormal returns around SEO announcements: from −1 to +1 day, from −3 to +3 days, and from −10 to +10 days around the announcement date (date 0). These announcement period abnormal returns are over and above beta times the S&P index return (the green plot), the value-weighted CRSP market return (the red plot), or equal-weighted CRSP market return (the blue plot). The time period is SEO announcements made from 2010 to 2015.



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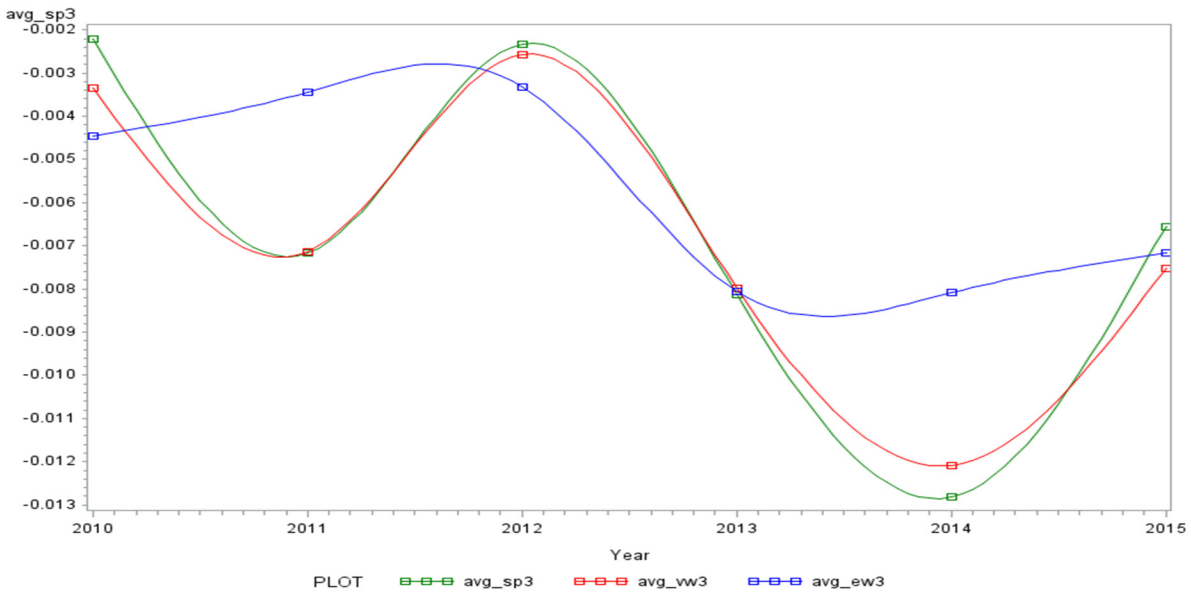

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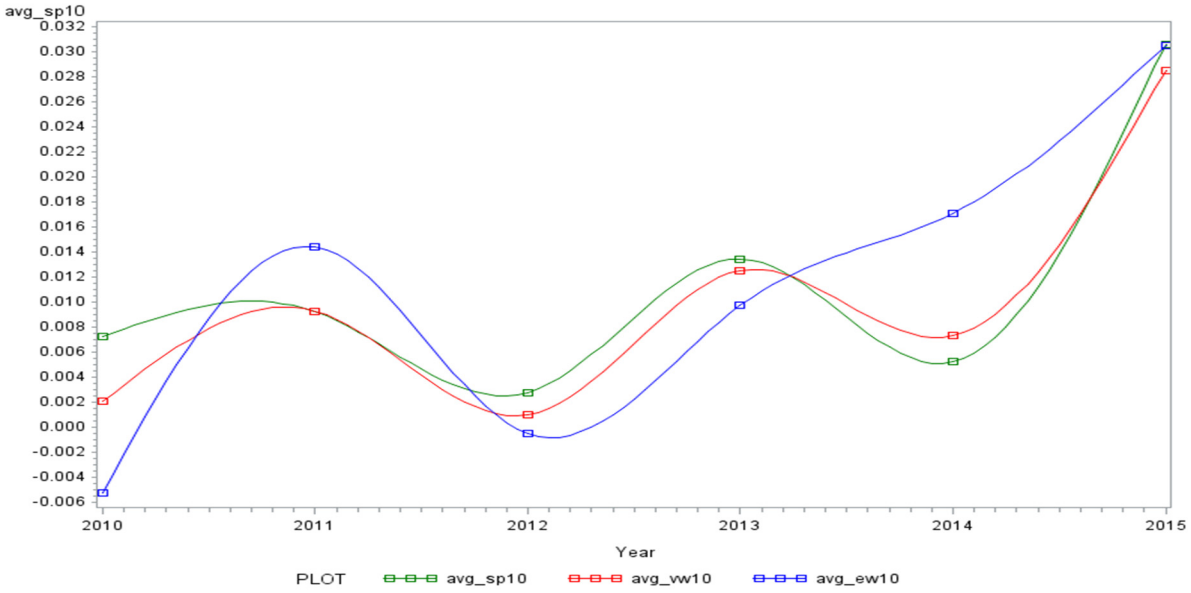
Figure 1. *Cont.*



(**C**)

Figure 1. Announcement period abnormal return. Panel **A**: Average −1 to +1 Day Abnormal Return by Year. Panel **B**: Average −3 to +3 Day Abnormal Return by Year. Panel **C**: Average −10 to +10 Day Abnormal Return by Year.

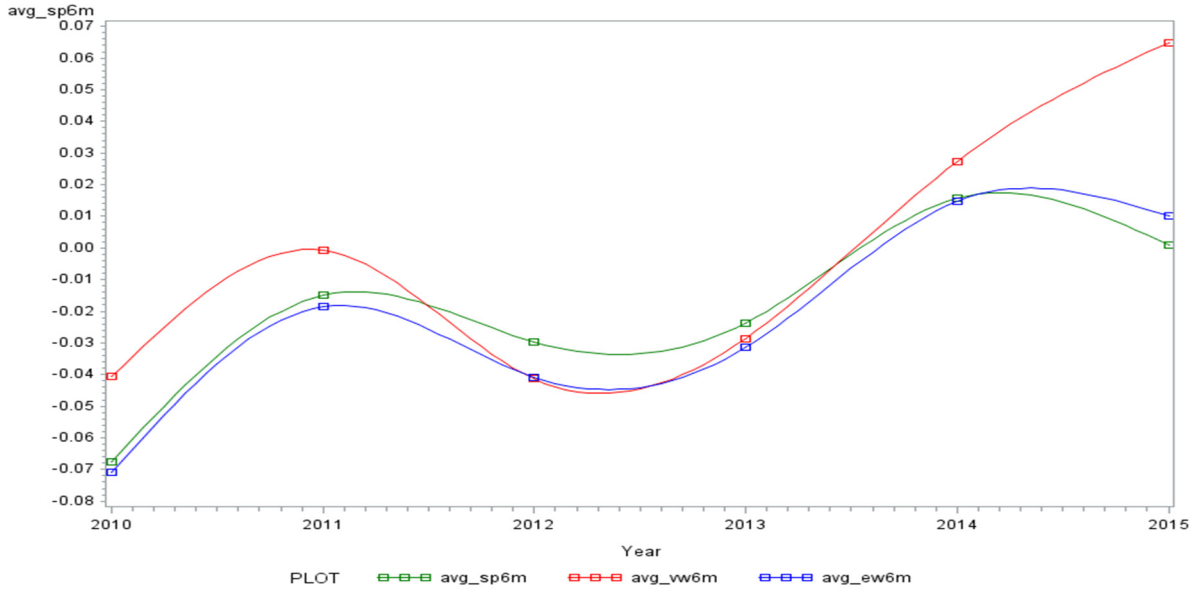
The two panels in Figure 2 show the year-by-year time series plots of long-term abnormal returns that generated 6 months and 12 months after the issue. Post-issue longer run returns are mostly negative, in line with Spiess and Affleck-Graves (1995), who argue that this may be because managers take advantage of overvaluation in markets. On average, the 12-month abnormal return is −4.71%, 2.37% lower than the 6-month abnormal return, depending on the benchmark, in line with Carlson et al. (2006), who point out that there is post-issuance underperformance of SEO stocks using options framework.

This figure shows the time series plots of annual average long-term post-SEO abnormal returns: the cumulative abnormal return (CAR) 6 months and 12 months post-SEO over and above value-weighted CRSP market return (the red plot), or equal-weighted CRSP market return (the blue plot). The time period is SEO announcements made from 2010 to 2015.

For the whole sample, the year-by-year SEO descriptive statistics a shown in Table 1.

Table 1. Descriptive statistics of SEOs by year. This take shows the year-by-year descriptive statistics of our final sample of Seasoned Equity Offering announcements made from 2010 to 2015.

Year	Number of SEOs	Average Proceeds (USD Million)	Average Time between Announcement and Issue (Days)	Percentage Bank SEOs	Average Equity Beta
2010	164	335.4	467.5	44.5%	1.3
2011	393	170.9	318.2	33.8%	1.4
2012	407	289.9	266.8	39.8%	1.3
2013	455	190.2	189.2	33.2%	1.2
2014	406	200.2	129.9	26.8%	0.7
2015	232	256.7	36.3	19.4%	1.4
Overall	2139	270.7	311.9	36.6%	1.3



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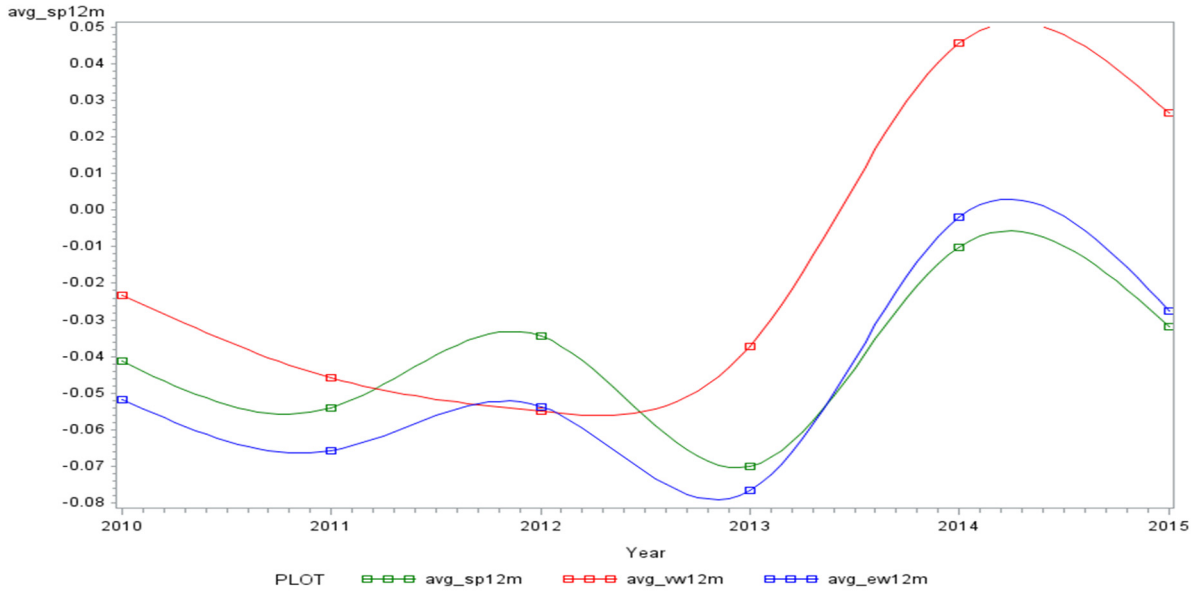


(**B**)

Figure 2. Longer Term Post-Issue Abnormal Return. Panel **A**: Average 6-month post-issue Cumulative Abnormal Return by Year. Panel **B**: Average 12-month post-issue Cumulative Abnormal Return by Year.

The number of announcements and the average proceeds have remained more or less steady, around the average, over the years, but the average time between announcement and the issue and the proportion of SEOs announced by banks, as they seemed to have shored up their capital adequacy over time, have decreased. The SEOs are announced, on average, by firms that are slightly riskier (in terms of the equity beta) firm than the market. The year-by-year abnormal stock returns are shown in Table 2: short-term abnormal return in Panel A, and long-term post-issue abnormal returns in Panel B.

Table 2. SEO returns by year. Panel A reports the average percentage announcement period abnormal returns, computed in different ways over different periods around the SEO announcement date, while Panel B reports the average longer-run post-issue abnormal returns, computed in different ways over different periods after the SEO issue date. All variables are defined in the Appendix A.

Panel A

Year	SP AR3	SP AR7	SP AR 21	VW AR3	VW AR7	VW AR 21	EW AR3	EW AR7	EW AR 21
2010	1.05	−0.22	0.07	0.99	−0.33	0.20	0.83	−0.45	−0.53
2011	−0.56	−0.72	0.92	−0.52	−0.71	0.93	−0.23	−0.34	1.44
2012	−0.45	−0.23	0.28	−0.46	−0.33	0.09	−0.54	−0.33	−0.05
2013	−0.68	−0.81	1.35	−0.66	−0.79	1.25	−0.64	−0.80	0.97
2014	−0.84	−1.28	0.52	−0.83	−1.21	0.73	−0.79	−0.81	1.71
2015	−0.39	−0.65	3.06	−0.43	−0.75	2.85	−0.48	−0.72	3.05
Overall	−0.24	−0.57	0.48	−0.26	−0.63	0.32	−0.28	−0.73	−0.18

Panel B

Year	SP CAR6	SP CAR12	VW CAR6	VW CAR12	EW CAR6	EW CAR12
2010	−6.75	−4.14	−7.09	−5.17	−4.07	−2.32
2011	−1.49	−5.39	−1.85	−6.58	−0.07	−4.59
2012	−2.97	−3.44	−4.09	−5.37	−4.13	−5.51
2013	−2.37	−7.01	−3.14	−7.67	−2.86	−3.71
2014	1.57	−1.01	1.48	−0.19	2.74	4.57
2015	0.10	−3.19	1.02	−2.75	6.48	2.66
Overall	−2.97	−5.35	−3.21	−6.02	−0.83	−2.75

Short selling around the SEO announcement may provide an opportunity to profit from share price manipulation (Deshmukh et al. 2017), which may explain the pattern in Panel A that shows reversal as we move from 7 days around the announcement date (generally negative) to 21 days around the announcement date (generally positive). For long-term post-issue abnormal returns, shown in Panel B, the average overall abnormal return is negative for all the benchmarks and becomes more negative, on average, as we examine longer-run returns. This is in line with previous studies that have documented negative long-term abnormal stock returns following SEO issues (Eberhart and Siddique 2002; Lizińska 2018). However, the long-term abnormal stock returns were higher in the later years of our sample—2014 and 2015—and some even turned positive.

4. Methods and Results

4.1. Methods

To examine the determinants of the announcement period abnormal returns and post-issue longer term returns, the patterns of which were documented above, we use several methods. Indeed, the objective of the paper is to show that the results could change depending on the method used. In Method 1, we start with a panel regression using our full sample, with the various abnormal returns as the dependent variables and the groups of explanatory variables as the independent variables, controlling for year and industry fixed effects and offer size. We document the significant explanatory variable(s), at the 1% level, for each announcement period and longer-term abnormal return. This is the normal "kitchen-sink" panel regression approach.

In Method 2, to reduce the number of explanatory variables, we perform principal component analysis on each factor group (on the standardized "z" variables) and determine the principal component(s) that explain at least 80% of each factor group. The original independent variables of each factor group that have at least 75% correlation with each of the important principal components identified above are now the reduced number of independent variables in the panel regressions to explain each abnormal return, after

controlling for year and industry fixed effects and offer size. In this method, we are more careful in selecting the explanatory variables.

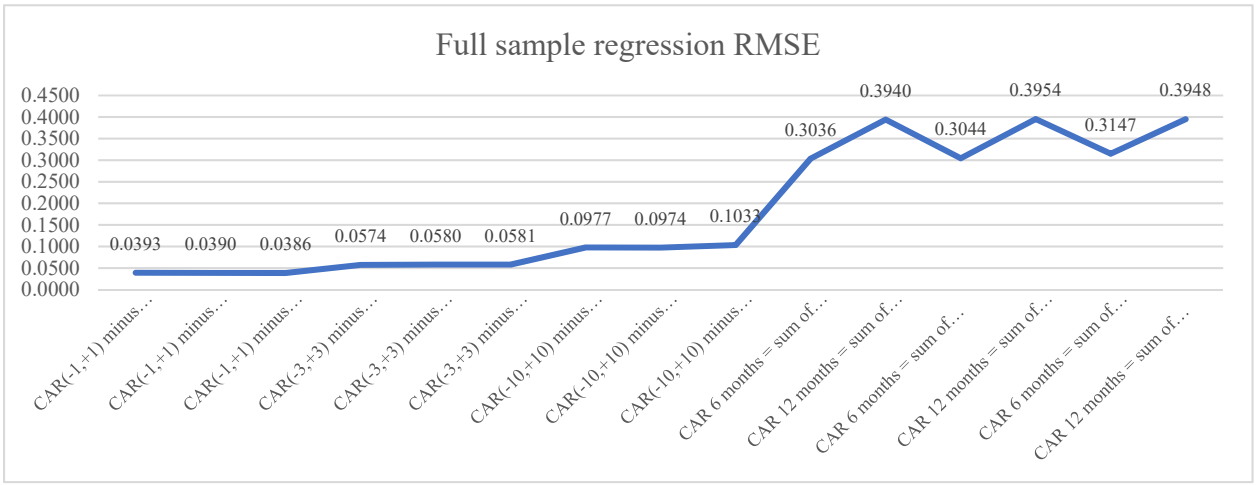
Method 3's approach to identify the key determinants of abnormal returns is a year-by-year one. We perform principal component analysis on each factor group each year and determine the principal component(s) that explain at least 80% of each factor group each year. The original independent variables of each factor group that have at least 75% correlation with each of the important principal components identified above are now the reduced number of independent variables each year (could be different) in year-by-year regressions to explain each abnormal return. This method allows the determinants of the short- and longer-term returns to vary by year, which would not have been feasible using all explanatory variables because of their number.

In Method 4, we use a random forest regression method to check the key determinants of SEO abnormal returns. As Biau and Scornet (2016) suggests, when we have a dataset with a large number of variables, a random forest algorithm can be a successful classification and regression method. In other classification processes, as used in the methods 2 and 3, or in machine learning, the predictor variables space is required to be substantially reduced, which can lead to missing some insight of a complex dataset. As Uddin et al. (2022); Liu et al. (2015); and Zou et al. (2015) show, the random forest regression method is widely used in the finance industry, for example in fraud detection, credit analysis, prices, etc., when we have high-dimensional data. Following Liu et al. (2012), the random forest regression can be summarized as follows. Random forest regression is a method of machine learning that involves planting trees randomly and then using reliable predictors by taking an average of trees. Following Archer and Kimes (2008) and Biau and Scornet (2016), the random forest classifier generates the effectiveness of each variable in each group, and can identify the important predictor(s) among all the candidate predictors. A random forest classifier does not require reduction in the predictor space prior to classification, as in Methods 2 and 3. In Method 5, we conduct the random forest regression year-by-year.

In our approach, we used 40% (see Hastie et al. 2009) of the sample in each regression for training and the remainder for testing. For evaluating the performance of predictor(s), following Chai and Draxler (2014), the root mean squared error (RMSE) that measures the error between the statistical result and real data is an appropriate measure of the method's performance. Using n samples of errors calculated as (e_i, i = 1, 2, . . . , n), the RMSE is calculated for the data set as:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n} e_i^2}$$

A large RMSE indicates that the method is inaccurate. In Figure 3, we can see differences in the values of RMSE between short-term abnormal returns and long-term post-issue abnormal returns. Panel A reports the RMSE value for full-sample regression, and Panel B the RMSE for the year-by-year regression. We see only small differences between the method's performance for abnormal returns over the same period but using different benchmarks, but the accuracy is better for the short-term (announcement period) abnormal returns (also see Mitchell and Stafford 2000). Figure 3 reports RMSE values generally under 0.2 for short-term abnormal returns and under 0.55 for long-term abnormal returns. This indicates an efficient method, and the variables are interpretable explanatory variables for the dependent variables.



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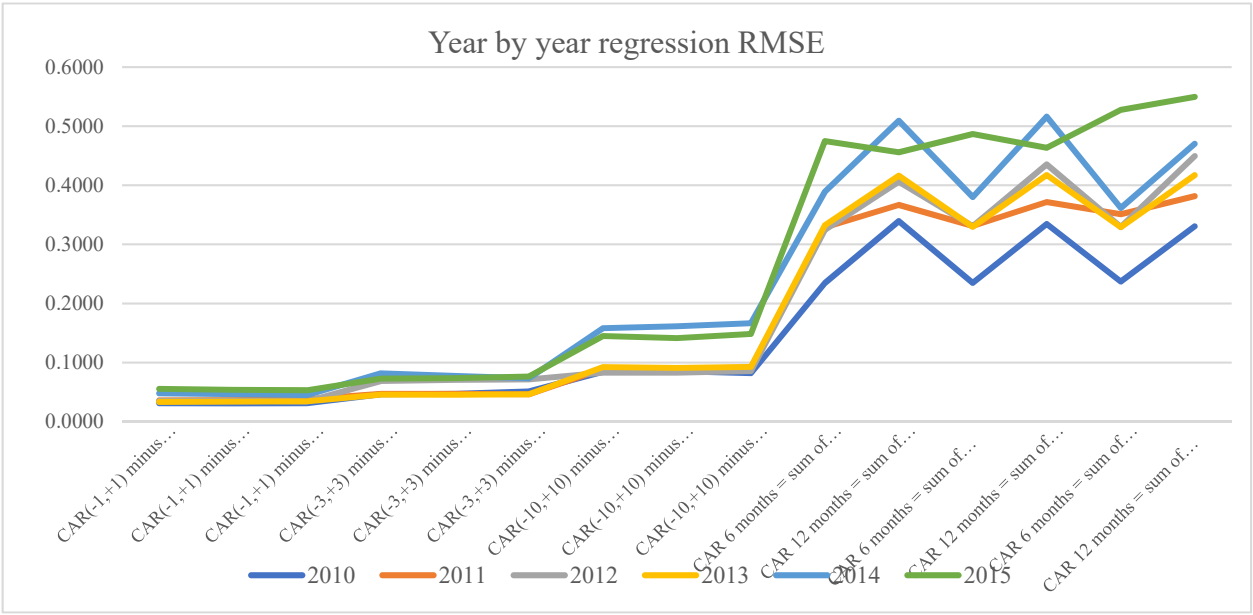

(**B**)

Figure 3. Root-mean-square errors of random forest regressions. The 2 panels below show the root-mean-squared errors (RMSE) for the full sample (Panel **A**) and the year-by-year sample (Panel **B**) that measure the error between the statistical result and data, and is a measure of the Method performance.

4.2. Empirical Results

Method 1, as detailed above, is a panel regression using our full sample, with the various abnormal returns as the dependent variables and the groups of explanatory variables as the independent variables with year and industry fixed effects and offer size. Table 3 reports the significant explanatory variable(s), at the 1% level, in bold, for each announcement period and longer-term abnormal return that significantly affect at least three abnormal returns. These turn out to be the return on assets computed as at one quarter immediately prior to the SEO announcement (ROA-1), which affects all abnormal returns significantly positively, except for the 3-day announcement period abnormal returns. For 3-day abnormal returns, the return on equity computed as at one quarter immediately prior to the SEO announcement (ROE-1), and the operating income to asset ratio computed

as at four quarters before the SEO announcement (OI/A-4) show significantly positive associations.

Table 3. Determinants of returns: regression results.

Y_t	Significant Explanatory Variables (Name and Significance)							
	ROA 1	**ROE 1**	**OI/A 1**	**BTM 2**	**OI/A 4**	**CPI**	**12MS**	**12MN**
SP CAR(−1,+1)	0.005	**0.006**	−0.001	0.001	**0.013**	**−0.061**	**0.868**	**−0.418**
	(1.54)	**(3.85)**	(−0.20)	(0.17)	**(4.29)**	**(−3.08)**	**(3.52)**	**(−4.02)**
VW CAR(−1,+1)	0.006	**0.006**	−0.015	0.001	**0.014**	**−0.061**	**0.840**	**−0.406**
	(1.78)	**(3.83)**	(−0.43)	(0.17)	**(4.43)**	**(−3.05)**	**(3.39)**	**(−3.89)**
EW CAR(−1,+1)	**0.009**	**0.006**	−0.004	0.001	**0.015**	**−0.054**	**0.716**	**−0.370**
	(2.54)	**(3.59)**	(−1.16)	(0.09)	**(4.79)**	**(−2.64)**	**(2.84)**	**(−3.48)**
SP CAR(−3,+3)	**0.020**	**0.008**	−0.011	0.008	**0.013**	−0.033	0.767	**−0.491**
	(4.11)	**(3.86)**	(−2.19)	(1.23)	**(2.95)**	(−1.15)	(2.17)	**(−3.29)**
VW CAR(−3,+3)	**0.021**	**0.008**	**−0.012**	0.009	**0.012**	−0.031	0.711	**−0.473**
	(4.44)	**(3.91)**	**(−2.43)**	(1.25)	**(2.81)**	(−1.1)	(2.01)	**(−3.17)**
EW CAR(−3,+3)	**0.026**	**0.009**	**−0.016**	0.009	**0.012**	−0.022	0.488	**−0.393**
	(5.46)	**(3.99)**	**(−3.20)**	(1.12)	**(2.64)**	(−0.78)	(1.37)	**(−2.62)**
SP CAR(−10,+10)	**0.055**	**0.010**	**−0.030**	**−0.060**	0.012	0.023	0.701	**−0.825**
	(6.68)	**(2.70)**	**(−3.58)**	**(−4.65)**	(1.59)	(0.48)	(1.16)	**(−3.23)**
VW CAR(−10,+10)	**0.063**	**0.010**	**−0.035**	**−0.059**	0.012	0.026(0.53)	0.469	**−0.734**
	(7.59)	**(2.67)**	**(−4.18)**	**(−4.54)**	(1.60)		(0.77)	**(−2.87)**
EW CAR(−10,+10)	**0.090**	**0.010**	**−0.053**	**−0.059**	0.012	0.032	−0.337	−0.454
	(10.71)	**(2.57)**	**(−6.18)**	**(−4.45)**	(1.59)	(0.64)	(−0.55)	(−1.74)
SP CAR 6 months	**0.077**	0.018	−0.041	−0.006	−0.009	0.047	1.597	−1.122
	(3.57)	(1.86)	(−1.88)	(−0.19)	(−0.46)	(0.37)	(1.01)	(−1.68)
SP CAR 12 months	**0.103**	**0.031**	−0.015	−0.033	−0.037	0.021	1.974	−0.966
	(3.84)	**(2.54)**	(−0.56)	(−0.77)	(−1.51)	(0.13)	(1.00)	(−1.16)
VW CAR 6 months	**0.080**	0.018	−0.040	−0.005	−0.009	0.055	1.518	−1.099
	(3.71)	(1.84)	(−1.86)	(−0.15)	(0.43)	(0.43)	(0.96)	(−1.65)
VW CAR 12 months	**0.115**	**0.032**	−0.023	−0.029	−0.038	0.026	2.129	−1.045
	(4.25)	**(2.69)**	(−0.85)	(−0.70)	(−1.51)	(0.17)	(1.08)	(−1.25)
EW CAR 6 months	**0.096**	0.017	−0.046	−0.003	−0.012	0.072	1.162	−0.981
	(4.43)	(1.75)	(−2.10)	(−0.07)	(−0.62)	(0.56)	(0.73)	(−1.47)
EW CAR 12 months	**0.156**	**0.037**	−0.053	−0.022	−0.039	0.039	2.433	−1.184
	(5.72)	**(3.05)**	(−1.92)	(−0.50)	(−1.56)	(0.24)	(1.22)	(−1.40)

Table 3 shows the significant explanatory variables (shown in bold), using regressions with different announcement period abnormal returns and post-issue longer-term abnormal returns as the dependent variables, and the different groups of all explanatory variables, as the independent variables—firm variables (Group A), economic and fixed income variables (Group B), and market variables (Group C), with time and industry fixed effects and offer size. The coefficients and t statistics (in parenthesis) are shown. The regression specification is

$$AR = \alpha + \sum_i \beta_i v_i + \sigma$$

where v_i denotes all of the variables in three groups. All variables are defined in the Appendix A.

The 21-day abnormal return is significantly affected by operating income to asset ratio computed as of one quarter before the SEO announcement (OI/A-1) positively, and the book-to-market ratio as of two quarters before the announcement (BTM-2) negatively, as it is an inverse measure of growth options. Generally, some measure of firm profitability of the recent past affects the abnormal returns.

There are three variables in the economy-wide, fixed income, and stock market variable groups that we find are significantly correlated with abnormal returns. The most recent consumer price index (CPI) prior to the announcement affects the 3-day abnormal return negatively (see Sirucek 2012). S&P 500 index return and Nasdaq index return in 12 months

prior to SEO announcement significantly affect the 3-day abnormal return. These results may imply the influence of market sentiment; see Vozlyublennaia (2014) and Wang et al. (2018), who argue that the index return of the previous period affects investor attention now, and can lead to more short-term volatility around events such as SEOs.

Method 2 uses the principal component analysis (PCA) method to extract the important information from our dataset. Abdi and Williams (2010) argue that this technique can reduce a large dataset to fewer main variables that capture the information contained as a set of new orthogonal variables. In our analysis, we use all the principal components (PCs) that can together explain at least 80% of each set of the original variables. As Table 4A shows, there are five PCs extracted from Group A, three PCs from Group B, and two PCs from Group C (see Table 4A). Table 4A also reports the variables that are most correlated to each of the above important PCs. We use 75% minimum correlation as the threshold and consider all original variables that satisfy this criterion. Often, the most significant PCs are most correlated with variables which need not be the significant ones in the all-sample regression of Method 1. For Group A, the most significant PC is significantly correlated with operating income, OI/A immediately before the announcement. For Group B, the result is consistent with the all-sample regression in that the most significant PC is mostly correlated with CPI index and has an explanatory ability of 46.9%. For Group C, the most significant two PCs are most correlated with returns of market indices 6 months and 12 months prior to the SEO announcement.

Table 4. Determinants of returns: regression results using principal components of the different groups of explanatory variables—full sample. Panel A shows the Eigenvalues of the most important Principal Components of the different groups of explanatory variables—firm variables (Group A), economic and fixed income variables (Group B), and market variables (Group C). Additionally, reported are the significant original explanatory variables, correlated most (at least 75%) with each of the most important principal component (PC). Panel B shows the significant explanatory variables (shown in bold), using regressions with different announcement period abnormal returns and post-issue longer-term abnormal returns as the dependent variables, and the significant original variables most correlated with the PCs, as shown in Panel A, with time and industry fixed effects and offer size. The coefficients and t statistics (in parenthesis) are shown. All variables are defined in the Appendix A.

Panel A

PC	EigenValue (Explaining What Proportion of Total Group of Variables' Variability)	Original Variable or Variables the PC Is Most Correlated with (Correlation More than 75%)			
Firm Variables PC1	0.251	OI/A 1			
Firm Variables PC2	0.172	MVE 1	MVE 2	MVE4	
Firm Variables PC3	0.135	BTM 2	BTM 1	BTM 4	
Firm Variables PC4	0.082	ROA 4	ROA 2		
Firm Variables PC5	0.075	ROA 1	OI/A 1		
Economy Variables and Fixed Income PC1	0.469	CPI	GDP	UNEMP	25YGR
Economy Variables and Fixed Income PC2	0.203	TED	25YGR		
Economy Variables and Fixed Income PC3	0.164	5YGR	10 YGR		
Stock Market Variables PC1	0.528	6MS	6MD	6MN	3MS
Stock Market Variables PC2	0.296	12MS	12MN	12MD	

Table 4. *Cont.*

Panel B						
The regression specification is $AR=\alpha+\beta_1 OIA1+\beta_2 MVE1+\beta_3 BTM2+\beta_4 ROA4+\beta_5 ROA2+\beta_6 ROA1+\beta_7 CPI+\beta_8 GDP+\beta_9 TED+\beta_{10} 6MS+\beta_{11} 12MS+\beta_{12} 12MN+\sigma$ **All variables are defined in the Appendix A.**						
Y_t	**Significant Explanatory Variables (Name and Significance)**					
	ROA 4	**ROA 2**	**ROA 1**	**GDP**	**12MS**	**12MN**
SP CAR(−1,+1)	**0.006**	**−0.008**	0.001	0.005	**0.574**	**−0.302**
	(3.41)	**(−4.52)**	(0.38)	(1.47)	**(3.13)**	**(−3.60)**
VW CAR(−1,+1)	0.006	**−0.008**	0.002	0.005	**0.540**	**−0.287**
	(3.56)	**(−4.48)**	(0.63)	(1.44)	**(2.94)**	**(−3.40)**
EW CAR(−1,+1)	**0.007**	**−0.007**	0.004	0.006	**0.472**	**−0.262**
	(4.00)	**(−3.93)**	(1.26)	(1.60)	**(2.54)**	**(−3.07)**
SP CAR(−3,+3)	0.002	**−0.011**	**0.019**	0.000	0.509	**−0.313**
	(0.93)	**(−4.50)**	**(4.41)**	(0.00)	(1.95)	**(−2.62)**
VW CAR(−3,+3)	0.002	**−0.011**	**0.021**	0.001	0.445	−0.289
	(0.96)	**(−4.47)**	**(4.68)**	(0.13)	(1.70)	(−2.41)
EW CAR(−3,+3)	0.002	**−0.010**	**0.023**	0.004	0.219	−0.224
	(0.97)	**(−4.05)**	**(5.20)**	(0.81)	(0.84)	(−1.87)
SP CAR(−10,+10)	**−0.011**	**−0.022**	**0.038**	−0.018	0.249	−0.531
	(−2.52)	**(−4.98)**	**(4.86)**	(−2.07)	(0.53)	(−2.49)
VW CAR(−10,+10)	−0.010	**−0.022**	**0.044**	−0.018	0.032	−0.439
	(−2.43)	**(−5.03)**	**(5.62)**	(−2.01)	(0.07)	(−2.04)
EW CAR(−10,+10)	−0.010	**−0.022**	**0.067**	−0.009	−0.572	−0.253
	(−2.23)	**(−4.69)**	**(8.07)**	(−1.03)	(−1.17)	(−1.12)
SP CAR 6 months	−0.015	0.005	**0.048**	−0.029	2.194	−1.081
	(−1.46)	(0.51)	**(2.52)**	(−1.39)	(1.95)	(−2.09)
SP CAR 12 months	**−0.035**	0.002	**0.077**	**−0.078**	1.892	−0.676
	(−2.62)	(0.12)	**(3.16)**	**(−2.84)**	(1.31)	(−1.02)
VW CAR 6 months	−0.017	0.005	**0.050**	−0.031	2.189	−1.059
	(−1.66)	(0.51)	**(2.61)**	(−1.39)	(1.93)	(−2.04)
VW CAR 12 months	**−0.037**	0.000	**0.086**	**−0.073**	2.211	−0.801
	(−2.81)	(0.05)	**(3.51)**	**(−2.63)**	(1.52)	(−1.20)
EW CAR 6 months	**−0.023**	0.005	**0.067**	−0.025	2.053	−0.976
	(−2.17)	(0.42)	**(3.42)**	(−1.14)	(1.77)	(−1.84)
EW CAR 12 months	**−0.043**	−0.005	**0.127**	−0.055	3.033	−1.116
	(−3.13)	(−0.38)	**(5.06)**	(−1.92)	(2.03)	(−1.63)

Table 4B shows all original variables (most corrected with the most significant PCs as explained above) that were significantly associated with at least two abnormal returns at the 1% significance level, after controlling for year and industry fixed effects and offer size. For short-term abnormal returns, ROA-1 affected 7-day and 21-day abnormal returns, positively and significantly, while ROA-4 impacted only 3-day abnormal returns positively. ROA may be positively correlated to income growth (Heikal et al. 2014), and SEO announcements may be perceived to further this growth by providing discretionary funding. Among the other variables, 12MS affected the 3-day abnormal returns positively and 12MN affected the 3-day abnormal returns negatively, consistent with the statistical method 2 full-sample regression. ROA-1 is still a significantly positive factor for all the long-term abnormal returns (see Miwa (2016), who argues that the investor sentiment is positively affected by financial statements and its key variables such as profitability).

In Method 3, generally, in the year-by-year regressions using PCs, the firm's financial variables and macroeconomic variables affected abnormal returns. Table 5 reports the variables and the year that they have significant effects on the abnormal returns at the 1% significance level. From the results reported for each year, the significant variables affecting abnormal returns varied. In 2010, the short-term abnormal returns were affected by the book-to-market ratios reflecting future growth options from the equity issue, unemploy-

ment rate, and T-bill rate macro variables. In 2011, the short-term abnormal return was affected by different financial ratios (OI/A-2, for example) and different macro variables (CPI, for example) (see Antonakakis et al. 2017), who showed that inflation may have a significant positive influence on stock prices). In 2012, the short-term abnormal return was significantly affected by somewhat similar variables—ROE in firm-specific variables and the T-Bill rate in macro variables. Long-term abnormal returns were also significantly affected by ROE. In 2013, the short-term abnormal returns continued to be significantly affected by OI/A and ROA firm variables, while long-term returns were affected by GDP (see Jareño Cebrián and Negrut 2016). In 2014, there was no significant short-term factor that affected short-term abnormal returns. Long-term post-issue returns were affected by stock index returns, which typically affect investor sentiment (see Carlson et al. 2006; Mbanga et al. 2019). Finally, in 2015, the short-term abnormal returns were affected by the book-to-market ratio, while long-term abnormal returns were affected by BTM, OI/A, and ROA among firm variables, and by stock index returns.

Table 5 shows the year(s) in which an explanatory variable is significant (at the 1% level), using year-by-year regressions with different announcement period abnormal returns and post-issue longer-term abnormal returns as the dependent variables, and the significant original variables most correlated with the two most important principal components of the different groups of explanatory variables—firm variables (Group A), economic and fixed income variables (Group B), and market variables (Group C), with time and industry fixed effects and offer size, and which variables appear to be significant in which year. The years in which the variables are significant and the direction of the effect are shown. The regression specifications are:

$$2010: \quad AR = \alpha + \beta_1 BTM2 + \beta_2 BTM4 + \beta_3 BTM1 + \beta_4 MVE1 + \beta_5 ROE4 + \beta_6 10YGR + \beta_7 UNEMP + \beta_8 1YGR + \beta_{12} 6MD + \beta_{13} 6MS + \sigma$$

$$2011: \quad AR = \alpha + \beta_1 ROA2 + \beta_2 OIA2 + \beta_3 OIA1 + \beta_4 ROA1 + \beta_5 ROE4 + \beta_6 10YGR + \beta_7 5YGR + \beta_8 25YGR + \beta_9 AAA + \beta_{10} CPI + \beta_{11} CAPE + \beta_{12} 6MD + \beta_{13} 6MS + \beta_{14} 6MN + \sigma$$

$$2012: \quad AR = \alpha + \beta_1 ROE1 + \beta_2 ROE2 + \beta_3 1YGR + \beta_4 CAPE + \beta_5 6MD + \beta_6 6MS + \beta_7 6MN + \beta_8 3MN + \sigma$$

$$2013: \quad AR = \alpha + \beta_1 OIA4 + \beta_2 OIA1 + \beta_3 BTM4 + \beta_4 ROA2 + \beta_5 AAA + \beta_6 25YGR + \beta_7 10YGR + \beta_8 GDP + \beta_9 CPI + \beta_{10} BIG + \beta_{11} 12MS + \sigma$$

$$2014: \quad AR = \alpha + \beta_1 ROE2 + \beta_2 ROE1 + \beta_3 1MGR + \beta_4 3MD + \beta_5 12MD + \beta_6 12MS + \sigma$$

$$2015: \quad AR = \alpha + \beta_1 OIA2 + \beta_2 ROA2 + \beta_3 OIA1 + \beta_4 BTM2 + \beta_5 BTM1 + \beta_6 BTM4 + \beta_7 CPI + \beta_8 GDP + \beta_9 AAA + \beta_{10} 3MD + \sigma$$

All variables are defined in Appendix A.

Table 6A reports the results of random forest regression (*Method 4*) for the whole sample and reports the explanatory variables that significantly affected abnormal returns at the 1% level. These are OI/A-2 that was associated with all short-term abnormal returns negatively, and ROA-1, positively, consistent with the previous all-sample result (*Method 1*). Table 6B reports the results of random forest regression (*Method 5*) year by year and shows different explanatory variables significantly affected abnormal returns at the 1% level. In 2010, ROE-4; in 2011, ROA-1; and in 2012, ROE-4, were significantly associated with short-term returns. In 2013, OI/A-1 was significantly associated with 3-day abnormal return and ROE-4 with 12 months post-issue abnormal return. In 2014, ROA-1 was significantly associated with all abnormal returns except 7-day returns, and OI/A-4 with 12 months post-issue abnormal returns. In 2015, 6MD was significantly associated with short-term abnormal returns.

Table 5. Determinants of returns: regression results using principal components of the different groups of explanatory variables—year by year.

Y_t	BTM 2	BTM 4	BTM 1	ROE 4	UNEMP	1YGR	OI/A 2	CPI	OI/A 1	ROE 1	OI/A 4	ROA 2	GDP	12MD	3MD
SP CAR(−1,+1)		2010 (+)		2010 (−)		2010 (−)	2011 (−)		2013 (−)	2012 (+)	2013 (+)	2013 (−)			
VW CAR(−1,+1)		2010 (+)		2010 (−)		2010 (−)	2011 (−)		2013 (−)	2012 (+)	2013 (+)	2013 (−)			
EW CAR(−1,+1)		2010 (+)		2010 (−)		2010 (−)	2011 (−)		2013 (−)	2012 (+)	2013 (+)	2013 (−)			
SP CAR(−3,+3)	2010 (−)		2010 (+)	2010 (−)	2010 (+)	2010 (−)		2011 (+)			2013 (+)	2013 (−)			
VW CAR(−3,+3)	2010 (−)		2010 (+)	2010 (−)		2010 (−)		2011 (+)			2013 (+)	2013 (−)			
EW CAR(−3,+3)	2010 (−)		2010 (+)	2010 (−)				2011 (+)				2013 (−)			
SP CAR(−10,+10)	2015 (−)			2010 (−)	2010 (+)			2011 (+)				2013 (−)			
VW CAR(−10,+10)	2015 (−)			2010 (−)	2010 (+)	2012 (+)		2011 (+)				2013 (−)			
EW CAR(−10,+10)	2015 (−)			2010 (−)	2010 (+)	2012 (+)		2011(+)		2012 (+)		2013 (−)			
SP CAR 6 months	2015 (+)	2015 (−)													
SP CAR 12 months	2015 (+)	2015 (−)					2015 (+)		2011 (+)			2015 (−)		2014 (+)	2015 (−)
VW CAR 6 months	2015 (+)	2015 (−)													2015 (−)
VW CAR 12 months	2015 (+)	2015 (−)					2015 (+)		2011 (+)			2015 (−)		2014 (+)	2015 (−)
EW CAR 6 months	2015 (+)	2015 (−)								2012 (−)					2015 (−)
EW CAR 12 months	2015 (+)	2015 (−)					2015 (+)		2011 (+)	2012 (−)		2015 (−)	2013 (+)	2014 (+)	2015 (−)

Table 6. Random forest regression: full sample.

(A)		
Y_t	**OI/A 2**	**ROA 1**
SP CAR(−1,+1)	−0.007 (−4.40)	
VW CAR(−1,+1)	−0.007 (−4.37)	
EW CAR(−1,+1)	−0.007 (−3.83)	0.005 (2.62)
SP CAR(−3,+3)	−0.011 (−4.53)	0.012 (4.37)
VW CAR(−3,+3)	−0.011 (−4.54)	0.012 (4.57)
EW CAR(−3,+3)	−0.010 (−4.17)	0.013 (4.85)
SP CAR(−10,+10)	−0.025 (−5.80)	0.028 (5.65)
VW CAR(−10,+10)	−0.026 (−5.93)	0.031 (6.27)
EW CAR(−10,+10)	−0.027 (−5.88)	0.042 (8.08)
SP CAR 6 months		0.036 (3.06)
SP CAR 12 months		0.082 (5.45)
VW CAR 6 months		0.038 (3.24)
VW CAR 12 months		0.086 (5.68)
EW CAR 6 months		0.049 (4.00)
EW CAR 12 months		0.104 (6.62)

(B)										
Y_t	**ROE 4**	**ROA 1**	**3MD**	**6MN**	**OI/A-1**	**OI/A-4**	**12MN**	**5YGR**	**6MD**	**6MN**
SP CAR(−1,+1)	2010(−), 2012(+)	2011(+)	2011(+)		2013(−)			2015(+)	2015(+)	
VW CAR(−1,+1)	2010(−), 2012(+)	2011(+), 2014(−)	2011(+)		2013(−)			2015(+)	2015(+)	
EW CAR(−1,+1)	2010(−), 2012(+)	2011(+), 2014(−)			2013(−)			2015(+)	2015(+)	
SP CAR(−3,+3)	2010(−)	2010(+)							2015(+)	2015(−)
VW CAR(−3,+3)	2010(−)								2015(+)	2015(−)
EW CAR(−3,+3)	2010(−)							2015(+)	2015(+)	2015(−)
SP CAR(−10,+10)	2010(−)	2010(+), 2014(+)								
VW CAR(−10,+10)		2010(+), 2014(+)								
EW CAR(−10,+10)		2010(+), 2014(+)		2012(+)						
SP CAR 6 months		2014(+)								
SP CAR 12 months	2013(+)	2014(+)	2015(−)			2014(−)	2014(+)			
VW CAR 6 months		2014(+)	2015(−)							
VW CAR 12 months	2013(+)	2014(+)	2015(−)			2014(−)				
EW CAR 6 months		2014(+)	2015(−)							
EW CAR 12 months	2013(+)	2014(+)	2015(−)			2014(−)	2014(+)			

Table 6A shows the significant explanatory variables, using random forest regressions with different announcement period abnormal returns and post-issue longer-term abnormal returns as the dependent variables, and the different groups of all explanatory variables, as the independent variables—firm variables (Group A), economic and fixed income variables (Group B), and market variables (Group C), with time and industry fixed effects and offer

size. The coefficients and t statistics (in parentheses) of the significant variables (at 1% level) are shown. The regression specification is:

$$AR = \alpha + \beta_1 OIA2 + \beta_2 ROA1 + \beta_3 BIG + \beta_4 25YGR + \beta_5 3MN + \beta_6 6MN + \sigma$$

All variables are defined in Appendix A.

Table 6B shows the year(s) in which an explanatory variable is significant (at the 1% level), using year-by-year regressions with different announcement period abnormal returns and post-issue longer-term abnormal returns as the dependent variables, and the two most important variables from random forest regression analyses of the different groups of explanatory variables—firm variables (Group A), economic and fixed income variables (Group B), and market variables (Group C)—with time and industry fixed effects and offer size, and which variables appear to be significant in which year. The years in which the variables are significant are shown. The regression specifications are:

$$\begin{aligned}
2010: &\ AR = \alpha + \beta_1 ROE4 + \beta_2 ROA1 + \beta_3 BIG + \beta_4 25YGR + \beta_5 12MD + \beta_6 3MD + \sigma \\
2011: &\ AR = \alpha + \beta_1 ROA2 + \beta_2 ROA1 + \beta_3 BIG + \beta_4 25YGR + \beta_5 12MN + \beta_6 3MD + \sigma \\
2012: &\ AR = \alpha + \beta_1 ROE2 + \beta_2 ROE4 + \beta_3 BIG + \beta_4 5YGR + \beta_5 6MN + \beta_6 12MD + \sigma \\
2013: &\ AR = \alpha + \beta_1 ROE4 + \beta_2 OIA1 + \beta_3 BIG + \beta_4 5YGR + \beta_5 3MN + \beta_6 3MS + \sigma \\
2014: &\ AR = \alpha + \beta_1 OIA4 + \beta_2 ROA1 + \beta_3 BIG + \beta_4 5YGR + \beta_5 12MN + \beta_6 3MN + \sigma \\
2015: &\ AR = \alpha + \beta_1 ROE4 + \beta_2 ROA4 + \beta_3 25YGR + \beta_4 5YGR + \beta_5 6MN + \beta_6 3MD + \beta_7 6MD + \sigma
\end{aligned}$$

All variables are defined in the Appendix A.

Table 7 summarizes the results of all the statistical methods. ROA-1, the profitability variable from one quarter before the SEO announcement, affected the announcement period (short-term) abnormal returns most consistently. Husna and Satria (2019), for example, argued that the return on asset significantly reflects on firm value. Chen et al. (2019) argued that investor sentiments, influenced by the most recent earnings disclosed, have a positive impact on short-run abnormal returns. ROA-2 also significantly affected all short-term abnormal returns in two different methods. The market variables, 12MS and 12MN, significantly affected the 3-day abnormal returns in different ways. On long-term post-issue abnormal returns, besides ROA-1, the book-to-market ratios (reflecting the inverse of the growth potential) were significantly associated with all the abnormal returns in 2015. ROA-2 affected the 12 months post-issue abnormal returns negatively in 2015, and ROA-4 was also significantly associated with abnormal returns in the full-sample regression.

Table 7 shows the method using which a variable is significant (at the 1% level), from different regressions (ASR: full-sample regression; APR: full-sample PC regression; YBY: year-by-year PC regression; RFR: random forest regression; and RFY: random forest year-by-year regression), with different announcement period abnormal returns and post-issue longer-term abnormal returns as the dependent variables, and the different groups of all explanatory variables as the independent variables—firm variables (Group A), economic and fixed income variables (Group B), and market variables (Group C), with time and industry fixed effects and offer size. All variables are defined in Appendix A.

4.3. Robustness Check

To check the robustness of our full-sample regression results, we divided the full sample into two parts: 2010–2012 and 2013–2015. Table 8 reports the results of the regression and shows consistency between these two samples. The significant explanatory variables in the full sample are also significant in the same direction in the two subsamples.

Table 7. Summary of significant variables.

Y_t	BTM2	BTM4	BTM1	ROE4	UNEMP	1YGR	OI/A2	CPI	OI/A1	ROE1	6MD
SP CAR(−1,+1)		YBY		YBY, RFY		YBY	YBY, RFR	ASR	YBY, RFY	ASR, YBY	RFY
VW CAR(−1,+1)		YBY		YBY, RFY		YBY	YBY, RFR	ASR	YBY, RFY	ASR, YBY	RFY
EW CAR(−1,+1)		YBY		YBY, RFY		YBY	YBY, RFR	ASR	YBY, RFY	ASR, YBY	RFY
SP CAR(−3,+3)	YBY		YBY	YBY, RFY	YBY	YBY	RFR	YBY		ASR	RFY
VW CAR(−3,+3)	YBY		YBY	YBY, RFY		YBY	RFR	YBY		ASR	RFY
EW CAR(−3,+3)	YBY		YBY	YBY, RFY			RFR	YBY	ASR	ASR	RFY
SP CAR(−10,+10)	YBY			YBY, RFY	YBY		RFR	YBY	ASR	ASR	
VW CAR(−10,+10)	YBY			YBY	YBY	YBY	RFR	YBY	ASR	ASR	
EW CAR(−10,+10)	YBY			YBY	YBY	YBY	RFR	YBY	ASR	ASR, YBY	

Y_t	OI/A4	ROA2	GDP	12MD	3MD	ROA 1	12MS	12MN	ROA4	6MN	5YGR
SP CAR(−1,+1)	ASR, YBY	APR, YBY			RFY	RFY	ASR, APR	ASR, APR	APR		RFY
VW CAR(−1,+1)	ASR, YBY	APR, YBY			RFY	RFY	ASR, APR	ASR, APR	APR		RFY
EW CAR(−1,+1)	ASR, YBY	APR, YBY				RFR, RFY	ASR	ASR, APR	APR		RFY
SP CAR(−3,+3)	ASR, YBY	APR, YBY				ASR, APR, RFR		ASR, APR		RFY	
VW CAR(−3,+3)	ASR, YBY	APR, YBY				ASR, APR, RFR		ASR		RFY	
EW CAR(−3,+3)	ASR	APR, YBY				ASR, APR, RFR		ASR		RFY	RFY
SP CAR(−10,+10)		APR, YBY				ASR, APR, RFR		ASR			
VW CAR(−10,+10)		APR, YBY				ASR, APR, RFR		ASR			
EW CAR(−10,+10)		APR, YBY				ASR, APR, RFR				RFY	

Y_t	BTM2	BTM4	BTM1	ROE4	UNEMP	1YGR	OI/A2	CPI	OI/A1	ROE1
SP CAR 6 months	YBY	YBY								
SP CAR 12 months	YBY	YBY		RFY			YBY		YBY	
VW CAR 6 months	YBY	YBY								
VW CAR 12 months	YBY	YBY		RFY			YBY		YBY	ASR
EW CAR 6 months	YBY	YBY								YBY
EW CAR 12 months	YBY	YBY		RFY			YBY		YBY	ASR, YBY

Y_t	OI/A4	ROA2	GDP	12MD	3MD	ROA 1	12MS	12MN	ROA4
SP CAR 6 months						ASR, RFR			
SP CAR 12 months		YBY	APR	YBY	YBY	ASR, APR, RFR			APR
VW CAR 6 months					YBY	ASR, APR, RFR			
VW CAR 12 months		YBY	APR	YBY	YBY	ASR, APR, RFR			APR
EW CAR 6 months					YBY	ASR, APR, RFR			
EW CAR 12 months		YBY	YBY	YBY	YBY	ASR, APR, RFR			APR

Table 8. Robustness check: sub-sample test.

2010–2012											
Y_t	Significant Explanatory Variables (Name and Significance)										
	ROA 1	**BTM 1**	**OI/A 1**	**OI/A 2**	**BTM 4**	**OI/A 4**	**ROE 2**	**ROA 2**	**6MD**	**12MD**	**25YGR**
SP CAR(−1,+1)		**−0.019**	0.017	−0.024	**0.026**	**0.014**					
		(−3.11)	(2.77)	(−4.47)	**(3.09)**	**(3.15)**					
VW CAR(−1,+1)		**−0.019**	**0.017**	**−0.024**	**0.026**	**0.015**					
		(−3.06)	**(2.74)**	**(−4.46)**	**(5.97)**	**(3.29)**					
EW CAR(−1,+1)		**−0.019**	**0.016**	**−0.025**	**0.025**	**0.017**					
		(−2.97)	**(2.63)**	**(−4.53)**	**(5.74)**	**(3.58)**					
SP CAR(−3,+3)							0.013				
							(3.50)				
VW CAR(−3,+3)							0.012				
							(3.34)				
EW CAR(−3,+3)							0.010				
							(2.94)				
SP CAR(−10,+10)	**0.014**						0.016	**−0.030**	**−0.239**		
	(2.79)						(2.84)	**(−2.86)**	**(−3.03)**		
VW CAR(−10,+10)	**0.015**						0.015	**−0.031**	**−0.226**		
	(2.88)						(2.71)	**(−2.90)**	**(−2.87)**		
EW CAR(−10,+10)	**0.015**						0.014	−0.031	−0.243	0.195	
	(3.04)						(2.50)	(−2.91)	(−3.07)	(2.98)	
SP CAR 6 months											−0.921
SP CAR 12 months											(−2.58)
VW CAR 6 months											
VW CAR 12 months											
EW CAR 6 months											
EW CAR 12 months											

2013–2015								
Y_t	Significant Explanatory Variables (Name and Significance)							
	ROA 1	**BTM 1**	**OI/A 1**	**BTM 2**	**ROA 4**	**5YGR**	**6MD**	**6MS**
SP CAR(−1,+1)							**0.029**	**−0.043**
							(2.77)	**(−3.00)**
VW CAR(−1,+1)				**0.012**			**0.026**	**−0.039**
				(2.60)			**(2.55)**	**(−2.76)**
EW CAR(−1,+1)						**0.060**		
						(2.64)		
SP CAR(−3,+3)								
VW CAR(−3,+3)								
EW CAR(−3,+3)	**0.016**							
	(2.66)							
SP CAR(−10,+10)	**0.061**	**0.041**		**−0.044**				
	(5.47)	**(3.45)**		**(−3.47)**				
VW CAR(−10,+10)	**0.071**	**0.041**	**−0.034**	**−0.043**				
	(6.26)	**(3.40)**	**(−2.69)**	**(−3.34)**				
EW CAR(−10,+10)	**0.108**	**0.039**	**−0.055**	**−0.039**				
	(8.63)	**(2.88)**	**(−3.89)**	**(−2.70)**				
SP CAR 6 months	**−0.079**							
	(−2.71)							
SP CAR 12 months					**−0.089**			
					(−2.70)			
VW CAR 6 months	**−0.079**							
	(−2.70)							
VW CAR 12 months					**−0.092**			
					(−2.71)			
EW CAR 6 months								
EW CAR 12 months								

Table 8 shows the significant explanatory variables (shown in bold), using regressions with different announcement period abnormal returns and post-issue longer-term abnormal returns as the dependent variables, and the different groups of all explanatory variables as the independent variables—firm variables (Group A), economic and fixed income variables (Group B), and market variables (Group C), with time and industry fixed effects and offer size, after dividing the sample into two subsamples—2010–2012 and 2013–2015. The coefficients and t statistics (in parenthesis) are shown. All variables are defined in the Appendix A.

5. Conclusions

We examined the main influences of abnormal returns around SEO announcements and in the longer-run post-issue, using several different methodologies. Full-sample panel

regression showed that ROA-1, ROE-1, and 12MN were the most significantly associated with announcement period abnormal returns. The full-sample principal components analysis revealed ROA-2 as the most important factor. The full-sample random forest regression showed that the OI/A-2 and ROA-1 were the most important factors. In year-by-year methods, significant variables were different from year to year and there were some consistent variables that were associated with announcement period abnormal returns. In year-by-year regressions on variables most correlated with important PCs, we found that ROE-4 and ROA-2 were consistently influential, while the year-by-year random forest regression showed ROE-4 and ROA-1 were the most significant variables.

For the longer-term post-issue abnormal returns, full-sample regression showed ROA-1 had significant association, in agreement with the full-sample regression on principal components, and full-sample random forest regression analysis. Year-by-year regression on principal components showed a variety of factors significantly affected longer-run abnormal returns—book-to-market ratios among them. However, in year-by-year random forest regression, ROA-1 was the most consistent variable.

Overall, there were some variables such as past firm profitability, for example, the return on assets, that could consistently affect abnormal stock returns at the announcement of SEOs and in the post-issue period, but we found support for our hypothesis that several other significant explanatory variables depended on the statistical method used. This may be especially true when there are a large number of possible explanatory variables. Readers and users of results reported in empirical studies must keep this in mind.

There are some limitations to our study. One important limitation is obviously our relatively small size—2010–2015. The data came from Refinitiv's Securities Data Company's (SDC) Platinum Global Public Issues database, which has a subscription cost. We used the data we had, which also suited our purpose because we wanted to show that finding the correct significant explanatory variables is an issue that likely gets exacerbated when we have a smaller sample and a large number of candidate explanatory variables. Future studies can test our hypothesis using a longer time series of data, in different contexts (not just seasoned equity offerings), and with additional different methods.

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Appendix A. Definition of Variables

Firm Variables		
Variable	**Description**	**Source**
ROA-1	Return on asset in the quarter ending before the announcement date	Wharton Research Data Service (WRDS)
ROE-1	Return on equity in the quarter ending before the announcement date	Wharton Research Data Service (WRDS)
MVE-1	Market value of equity in the quarter ending before the announcement date	Wharton Research Data Service (WRDS)
BTM-1	Book value to market value in the quarter ending before the announcement date	Wharton Research Data Service (WRDS)
OI/A-1	Operating income to asset in the quarter ending before the announcement date	Wharton Research Data Service (WRDS)
ROA-2	Return on asset at the end of 2 quarters before announcement date	Wharton Research Data Service (WRDS)
ROE-2	Return on equity at the end of 2 quarters before announcement date	Wharton Research Data Service (WRDS)
MVE-2	Market value of equity at the end of 2 quarters before announcement date	Wharton Research Data Service (WRDS)
BTM-2	Book value to market value at the end of 2 quarters before announcement date	Wharton Research Data Service (WRDS)
OI/A-2	Operating income to asset at the end of 2 quarters before announcement date	Wharton Research Data Service (WRDS)
ROA-4	Return on asset at the end of 4 quarters before announcement date	Wharton Research Data Service (WRDS)
ROE-4	Return on equity at the end of 4 quarters before announcement date	Wharton Research Data Service (WRDS)
MVE-4	Market value of equity at the end of 4 quarters before announcement date	Wharton Research Data Service (WRDS)
BTM-4	Book value to market value at the end of 4 quarters before announcement date	Wharton Research Data Service (WRDS)
OI/A-4	Operating income to asset at the end of 4 quarters before announcement date	Wharton Research Data Service (WRDS)
Economy-wide Variables		
Variable	**Description**	
CAPE	The latest Shillller CAPE Rate disclosed before the announcement date	Shiller website
GDP	The latest US GDP Index disclosed before the announcement date	Federal Reserve Economic Data (FRED)
CPI	The latest US CPI Index disclosed before the announcement date	Federal Reserve Economic Data (FRED)
UNEMP	The latest Unemployment rate disclosed before the announcement date	Federal Reserve Economic Data (FRED)
GDPG	US GDP growth in past 1 year before announcement date	Federal Reserve Economic Data (FRED)
Fixed Income Variables		
Variable	**Description**	
1MGR	US 1-month T-Bill rate closing price on the day before the announcement date	Federal Reserve Economic Data (FRED)
1YGR	US 1-year T-Bill rate closing price on the day before the announcement date	Federal Reserve Economic Data (FRED)
5YGR	US 5-year government bond rate closing price on the day before the announcement date	Federal Reserve Economic Data (FRED)
10YGR	US 10-year government bond rate closing price on the day before the announcement date	Federal Reserve Economic Data (FRED)
25YGR	US 25-month government bond rate closing price on the day before the announcement date	U.S. Department of The Treasury
TED	TED rate closing price on the day before the announcement date	Federal Reserve Economic Data (FRED)
AAA	Moody AAA corporate bond rate closing price on the day before the announcement date	Federal Reserve Economic Data (FRED)
BIG	Moody below investment grade rate closing price on the day before the announcement date	Federal Reserve Economic Data (FRED)
Stock Market Variables		
Variable	**Description**	
3MD	DJIA Index returns from 3 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
6MD	DJIA Index returns from 6 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
12MD	DJIA Index returns from 12 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
3MS	S&P 500 Index returns from 3 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
6MS	S&P 500 Index returns from 6 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
12MS	S&P 500 Index returns from 12 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
3MN	Nasdaq Index returns from 3 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
6MN	Nasdaq Index returns from 6 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data
12MN	Nasdaq Index returns from 12 months before the announcement date to 1 day before the announcement date	Bloomberg Historical Data

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