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Chair of Finance and Banking

Seminar in Finance and Banking

Seminar Paper

Do Investors Care about Carbon Risk? Panel Data Analysis for the European Stock Market

Supervisors: Prof. Dr. Oliver Entrop, M. Sc. Andreas Barth

Edited by: Aleksandra Petrenko

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E-Mail: petren01@ads.uni-passau.de

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Extended abstract

In this seminar paper, the relationships between financial indicators, stock returns, and CO_2 emissions are investigated. We follow the methodology of Bolton and Kacperczyk (2021, pp. 531–533), but focus on the European market instead of the US. Our sample includes the top 5% of European companies by market capitalization and all European countries, excluding Russia and Ukraine. The data is on a yearly and monthly basis, and the period covered is from 01/01/2010 to 31/12/2023. The variables of interest are: 1) levels, growth rates, emission intensity normalized by revenue, and lagged levels of Scope 1, 2, and 3 CO_2 emissions; 2) continuous stock returns.

First, the data was logarithmized where necessary, normalized by economic values, and winsorized. Then, the fixed effects regressions were calculated, accounting for multicollinearity, heteroscedasticity, and autocorrelation.

The main findings are as follows:

Larger companies with significant assets tend to produce more emissions overall but are more CO_2-efficient in terms of their production and supply chains. Companies actively reinvesting in their business produce more Scope 1 and 2 emissions but reduce Scope 3 emissions, indicating a growing focus on the environmental practices of their supply chain providers. Earnings per share growth does not influence emissions. Changes in emissions are mostly unrelated to financial indicators. Industry plays an important role in determining all types of emissions, while country-specific factors significantly affect Scope 1 and 2 emissions.

For stock returns, we do not observe a significant, stable effect of CO_2 emissions. The weak positive effect of Scope 2 emissions intensity and the negative effect of lagged Scope 3 emission levels are significant for both monthly and yearly data. However, other weak effects disappear when the data frequency changes. The control variables are significant in all cases, and industry and time fixed effects are also important.

To summarize, the hypothesis of Bolton and Kacperczyk (2021) that stock returns are affected by CO_2 emissions is not supported.

Introduction and motivation

Sustainable investing has gained significant attention in recent years. Companies are increasingly focused on long-term financial performance and the development of new carbon-efficient industries. Moreover, governmental, reputational, and social pressures compel companies to invest in the green economy.

In this paper, we test the hypothesis of Bolton and Kacperczyk (2021) that CO2 emissions affect stock returns. Additionally, we investigate the economic determinants of CO2 emissions.

The structure of the paper is as follows: First, we conduct a literature review and classify previous findings. Next, we derive and clean the data. Finally, we perform a panel regression analysis with CO2 emissions and stock returns as the variables of interest.

Literature review

Methodology

For the literature review, papers published between 2020 and 2024 were selected. Two main sources were used: the SCOPUS database and a "snowball search," which involved examining papers referenced in the literature reviews of those found in SCOPUS. The topics of the papers were narrowed down to two aspects: CO_2 emissions and their impact on stock returns. Other sources of pollution or markets (e.g., bonds) were excluded from the search. Additionally, the literature list was restricted to journals rated "A+" and "A" according to the VHB ranking (see Appendix 1). Keywords used for the search included "carbon," "emissions," "stock," "returns," "green," "brown," and their combinations. Ultimately, we identified 9 high-quality papers, including the foundational paper by Bolton and Kacperczyk (2021), whose hypotheses and methodology serve as the basis for the quantitative analysis in this seminar paper.

Literature analysis

There is an ongoing discussion in the scientific field about whether CO2 emissions affect stock returns and the extent of their impact. The main carbon premium hypothesis is as follows: "Brown" companies tend to have higher abnormal returns than "green" ones due to higher carbon risk. Some studies (Alessi et al., 2021; Bolton and Kacperczyk, 2021; Pástor et al., 2022; Bolton and Kacperczyk, 2023) support this hypothesis. In contrast, other research shows that "green" companies outperform "brown" ones during stressful situations (Choi et al., 2020; Alessi et al., 2021) and when concerns about climate change increase (Pástor et al., 2022; Ardia et al., 2023).

However, the most recent studies tend to argue that carbon emissions have little to no relationship with stock returns or, at best, only a weak one (Pedersen et al., 2021; Aswani et al., 2024; Zhang, 2024). Such misalignment in the literature keeps the topic of the green premium relevant.

The literature is summarized and classified in the Table 1.

Table 1. Literature summary

Author(s)	Year	Sample	Method	CO2 effect on stock returns		
				Higher returns of green companies[1]	Higher returns of brown companies[1]	No effect[1]
Choi et al.	2020	74 countries	Panel regression	During abnormally warm weather	-	-
Alessi et al.	2021	STOXX	Linear factor models	During climate stress	Normally, together with environmental transparency	-
Pedersen et al.	2021	US	Linear factor models	Only on a 10% significance level	-	-
Basic paper: Bolton and Kacperczyk	**2021**	**US**	**Panel regression**	**-**	**For level and growth rate variables**	**For emission intensity**
Pástor et al.	2022	US	Panel regression	When concerns about climate change increase	Considering expected return	-
Ardia et al.	2023	S&P 500	Panel regression	When concerns about climate change increase unexpectedly	-	-
Bolton and Kacperczyk	2023	77 countries	Panel regression	-	For level and growth rate variables	-

[1] Under the conditions below.

Aswani et al.	2024	US, Europe	Panel regression	-	-	When using 1) emissions actually disclosed by firms, not estimated by vendors, and 2) emission intensity, not unscaled emissions
Zhang	2024	US and 79 countries	Panel regression, linear factor models	In the US, accounting for information publication lag (weak relationship)		For other countries, accounting for information publication lag

Empirical research

Methodology

To conduct empirical research for the European market, a sample was derived from the Datastream database using the Refinitiv Excel add-in. The sample includes the top 5% of European companies by market capitalization. This choice is justified by the availability of data: CO_2 emissions are largely not reported by small companies, and the Excel add-in has a limitation on the number of rows that can be imported. Additionally, Ukraine and Russia were excluded due to their unstable political situations and abnormal data. The time period is from the 01/01/2010 to 31/12/2023.

Ultimately, we included 427 European companies in the sample by ISIN (International Securities Identification Number). An overview of the companies by industry (Thomson Reuters Business Classification (TRBC) – "TRBC Industry Group Name") and country is presented in Tables 2 and 3. The most represented industry, by far, is "Banking Services," followed by "Machinery, Tools, Heavy Vehicles, Trains & Ships" and "Insurance." The majority of the companies come from the economically leading European countries: the United Kingdom, Germany, and France.

Table 2. Sample structure by industry

TRBC Industry Group Name	Number of companies
Aerospace & Defense	12
Automobiles & Auto Parts	10
Banking Services	49
Beverages	8
Biotechnology & Medical Research	4
Chemicals	15
Collective Investments	3
Communications & Networking	2
Computers, Phones & Household Electronics	1
Construction & Engineering	9
Construction Materials	4
Consumer Goods Conglomerates	3
Containers & Packaging	4
Diversified Industrial Goods Wholesale	2

Diversified Retail	1
Electric Utilities & IPPs	17
Electronic Equipment & Parts	2
Financial Technology (Fintech) & Infrastructure	1
Food & Drug Retailing	8
Food & Tobacco	13
Freight & Logistics Services	7
Healthcare Equipment & Supplies	12
Healthcare Providers & Services	3
Homebuilding & Construction Supplies	5
Hotels & Entertainment Services	9
Household Goods	1
Insurance	23
Investment Banking & Investment Services	14
Investment Holding Companies	6
Machinery, Tools, Heavy Vehicles, Trains & Ships	29
Media & Publishing	8
Metals & Mining	9
Multiline Utilities	7
Natural Gas Utilities	1
NULL	2
Oil & Gas	13
Oil & Gas Related Equipment and Services	2
Paper & Forest Products	2
Passenger Transportation Services	4
Personal & Household Products & Services	6
Pharmaceuticals	16
Professional & Commercial Services	13
Real Estate Operations	8
Renewable Energy	2
Residential & Commercial REITs	4
Semiconductors & Semiconductor Equipment	5
Software & IT Services	12
Specialty Retailers	7
Telecommunications Services	14
Textiles & Apparel	9
Transport Infrastructure	4
Water & Related Utilities	2

Table 3. Sample structure by country

Country	Number of companies
Austria	3

Belgium	10
Bosnia and Herzegovina	1
Croatia	1
Czech Republic	1
Denmark	15
Finland	13
France	52
Germany	58
Greece	3
Guernsey	1
Hungary	1
Ireland	8
Italy	23
Jersey	5
Luxembourg	7
Montenegro	1
Netherlands	30
Norway	12
NULL	2
Poland	8
Portugal	4
Romania	2
Spain	21
Sweden	36
Switzerland	41
United Kingdom	68

We will follow the methodology outlined in the foundational paper by Bolton and Kacperczyk (2021). To replicate their approach, we will import data to calculate control variables and derive the variables of interest as specified in the paper:

- Continuous returns;
- Scope 1 carbon emissions – direct emissions from production;
- Scope 2 carbon emissions – indirect emissions from consumption of purchased electricity, heat or steam;
- Scope 3 carbon emissions – other indirect emissions from the production of purchased materials, product use, waste disposal, outsourced activities, etc.

The overview of variables imported directly from Datastream is presented in Table 4. Most of the variables were converted to US dollars (USD) and adjusted from thousands or millions, but some still require further transformation. Yearly variables were repeated 12 times for each month. This could be an issue, which will be addressed later in the regression analysis.

Table 4. Raw data overview

Index	Name	Frequency	Measure
SCOPE_1	Carbon emissions Scope 1	yearly	tons
SCOPE_2	Carbon emissions Scope 2	yearly	tons
SCOPE_3	Carbon emissions Scope 3	yearly	tons
RI	Total Return Index	monthly	USD
SIZE	Market capitalization	monthly	millions of USD
M/B	Market-to-book value	monthly	-
ROE	Return on equity	yearly	%
LEVERAGE	Book value of leverage defined as the book value of debt divided by the book value of assets	yearly	-
CAPEX	Capital expenditures (CAPEX)	monthly	USD
ASSETS	Assets' book value	monthly	USD
PPE	Plant, property and equipment value	monthly	USD
REVENUE	Total revenue	monthly	USD
EPS	Earnings per share	monthly	USD
PRICE	Price of a share	monthly	USD
BETA	Capital Asset Pricing Model (CAPM) beta coefficient	yearly	-
VOLAT	Volatility - standard deviation of returns based on the past 12 months of monthly returns	yearly	%

Further data preparation and statistical analysis is conducted using R.

Data preparation

Ultimately, we calculated the following regressands and regressors in R (Table 5). Outliers were detected using box plots (Appendix 2) and were winsorized: values higher than the $(1-\alpha)$-quantile and lower than the α-quantile were replaced with the respective $(1-\alpha)$-quantile and α-quantile values. Final box plots are presented in the Appendix 3.

Table 5. Regressands and regressors

Index	Name	Formula	Winsorized at level
Variables of interest			
RET	Continuous stock returns	$\ln \frac{RI_t}{RI_{t-1}}$	7.5%
LOGSCOPE_1	Natural logarithm of carbon emissions Scope 1	$\ln \frac{SCOPE\_1}{12}$	1%
LOGSCOPE_2	Natural logarithm of carbon emissions Scope 2	$\ln \frac{SCOPE\_2}{12}$	1%
LOGSCOPE_3	Natural logarithm of carbon emissions Scope 3	$\ln \frac{SCOPE\_3}{12}$	-
del_SCOPE_1	Absolute change in Scope 1 carbon emissions	$SCOPE\_1_t - SCOPE\_1_{t-1}$	1%
del_SCOPE_2	Absolute change in Scope 2 carbon emissions	$SCOPE\_2_t - SCOPE\_2_{t-1}$	1%
del_SCOPE_3	Absolute change in Scope 3 carbon emissions	$SCOPE\_3_t - SCOPE\_3_{t-1}$	1%
LOGINT_SCOPE_1	Natural logarithm of Scope 1 carbon emissions intensity	$\ln \frac{SCOPE\_1/\ 12}{REVENUE}$	1%
LOGINT_SCOPE_2	Natural logarithm of Scope 2 carbon emissions intensity	$\ln \frac{SCOPE\_2/\ 12}{REVENUE}$	1%
LOGINT_SCOPE_3	Natural logarithm of Scope 3 carbon emissions intensity	$\ln \frac{SCOPE\_3/\ 12}{REVENUE}$	-
LAG_LOGSCOPE_1	Natural logarithm of the previous year Scope 1 carbon emissions	$\ln \frac{SCOPE\_1_{t-12}}{12}$	1%
LAG_LOGSCOPE_2	Natural logarithm of the previous year Scope 2 carbon emissions	$\ln \frac{SCOPE\_2_{t-12}}{12}$	1%

LAG_LOGSCOPE_3	Natural logarithm of the previous year Scope 3 carbon emissions	$\ln \frac{SCOPE\_3_{t-12}}{12}$	-
Controls			
LOGSIZE	Natural logarithm of market capitalization	$\ln(SIZE \times 1\,000\,000)$	-
B_to_M	Book-to-market value	$\frac{1}{M\_to\_B}$	3%
ROE	Return on equity	$ROE\ /\ 100$	1%
LEVERAGE	Book value of leverage defined as the book value of debt divided by the book value of assets	-	1%
LOG_INVEST_to_A	Natural logarithm of the investments normalized by the book value of assets	$\ln \frac{CAPEX}{ASSETS}$	1%
LOGPPE	Natural logarithm of plant, property and equipment	$\ln PPE$	-
BETA	Capital Asset Pricing Model (CAPM) beta coefficient	-	2.5%
VOLAT	Volatility - standard deviation of returns based on the past 12 months of monthly returns	$VOLAT\ /\ 100$	2.5%
SALESGR	Sales growth rate	$\frac{REVENUE_t - REVENUE_{t-1}}{REVENUE_{t-1}}$	1%
EPSGR	Earnings per share growth	$\frac{EPS_t - EPS_{t-1}}{PRICE}$	1%
MOM	The average of the most recent 12 months' returns, leading up to and including month $t-1$	$\frac{\sum_{i=1}^{12} RET_{t-i}}{12}$	1%

The descriptive statistics are presented below (Table 6). As shown, there are many missing values; however, the panel structure of the data helps to compensate for the lack of information. Outliers have been eliminated. Modified variables (e.g., logarithms, growth rates) result in some loss of information, however, the rows without dependent variables will be excluded from the analysis.

Table 6. Descriptive statistics

Variable	Missing values	Complete rate	Mean	Standard deviation	Minimum	Quartile 1	Median	Quartile 3	Maximum	Histogram
RET	6856	0,90	0,01	0,07	-0,12	-0,04	0,01	0,06	0,12	
LOGSCOPE_1	21418	0,70	8,88	3,15	1,12	6,85	8,66	10,80	16,08	
LOGSCOPE_2	21566	0,70	9,01	2,26	2,10	7,72	9,16	10,49	13,63	
LOGSCOPE_3	29732	0,59	10,47	3,45	-0,18	7,82	10,28	13,24	18,56	
del_SCOPE_1	26728	0,63	-10990,44	97497,72	-708333,33	-761,58	-21,08	250,00	316666,67	
del_SCOPE_2	26859	0,63	-2365,48	18694,42	-116644,42	-1800,00	-121,25	282,58	66666,67	
del_SCOPE_3	35934	0,50	65383,25	784656,10	-3220587,42	-1750,00	59,92	10000,00	4952272,42	
LOGINT_SCOPE_1	21430	0,70	-14,28	2,61	-20,60	-16,20	-14,38	-12,66	-8,24	
LOGINT_SCOPE_2	21578	0,70	-14,15	1,82	-19,91	-15,09	-14,06	-13,02	-10,13	
LOGINT_SCOPE_3	29744	0,59	-12,77	3,00	-21,57	-15,30	-12,67	-10,22	-5,62	
LAG_LOGSCOPE_1	23962	0,67	8,91	3,15	1,23	6,86	8,69	10,83	16,09	
LAG_LOGSCOPE_2	24110	0,66	9,05	2,25	2,17	7,75	9,19	10,52	13,67	
LAG_LOGSCOPE_3	32050	0,55	10,41	3,46	-0,18	7,75	10,16	13,17	18,56	
LOGSIZE	6388	0,91	23,22	1,35	13,24	22,55	23,23	24,03	26,90	
B_to_M	8133	0,89	0,65	0,52	0,08	0,27	0,49	0,89	2,27	
ROE	5869	0,92	0,15	0,16	-0,42	0,07	0,13	0,21	0,82	
LEVERAGE	5162	0,93	24,56	15,23	0,00	13,16	23,32	34,75	63,65	
LOG_INVEST_to_A	6980	0,90	-4,30	1,70	-9,21	-4,97	-3,76	-3,11	-2,05	
LOGPPE	5078	0,93	21,45	2,06	11,95	20,17	21,63	23,01	26,37	
BETA	6599	0,91	0,99	0,45	0,17	0,67	0,96	1,27	2,06	
VOLAT	10192	0,86	0,23	0,07	0,13	0,18	0,22	0,27	0,41	
SALESGR	7853	0,89	0,00	0,05	-0,22	-0,01	0,00	0,01	0,25	
EPSGR	8006	0,89	0,00	0,01	-0,05	0,00	0,00	0,00	0,05	
MOM	11917	0,83	0,01	0,02	-0,07	-0,01	0,01	0,02	0,07	

Regression analysis

Panel regression basics

Since the scope of this paper is limited, we will conduct only two types of regressions, following the methodology of the basic paper. First, we will examine the determinants of CO_2 emissions. Second, we will investigate whether CO_2 emissions impact stock returns, accounting for control variables.

As soon as we have an unbalanced panel data (observations for many individuals over a certain period with missing values), we will use proper regression methods to capture this structure, namely, a fixed effects panel regression, which is also used in the basic paper. The fixed effects model is defined as follows (using the notation of Baltagi, 2021):

$$y_{it} = \alpha + \boldsymbol{X}'_{it}\boldsymbol{\beta} + u_{it},\ i = 1, \dots,\ N,\ t = 1, \dots,\ T,$$

where i is an individual dimension and t is a time dimension, y_{it} is a dependent variable, α – an scalar, $\boldsymbol{X}'_{it}$ is a vector of K observations for one specific individual and time point, $\boldsymbol{\beta}$ – a $K \times 1$ vector of coefficients for each observed variable and u_{it} is an error term. The error term is defined as follows:

$$u_{it} = \mu_i + \lambda_t + v_{it},$$

where μ_i is an unobserved individual specific effect, λ_t is an unobserved time specific effect and v_{it} is a remainder disturbance. In other words, the model allows for an individual and time specific intercept uplift.

In our case, we introduce fixed effects for the industry, country and in case of monthly data – fixed effects for the month and the year. The regressions are implemented in R using an Ordinary Least Squares (OLS) regression with dummies.

As noted, some variables are measured on a yearly basis, while others are measured monthly. This discrepancy poses a risk, as variables repeated monthly lack variation within a year, potentially leading to spurious correlations. To address this issue, we:

1. Introduce time dummy variables for a monthly dependent variable and yearly independent variables – employ fixed effects for years and months, in order to capture seasonality.
2. Aggregate the data to a yearly level when the dependent variable is yearly, and the regressors are monthly.

Regression assumptions' testing

The correlation matrix for monthly data is presented in Figure 1 and for yearly data – in Figure 2. High correlations are observed among the emission variables, indicating that they should be isolated in the regression models. Additionally, the logarithm of property, plant, and equipment (LOGPPE) and LOG_INVEST_to_A are highly correlated with emissions, particularly with the logarithms and lagged logarithms of emissions. Regression models containing these variables should subsequently be tested for multicollinearity – high correlation between regressors.

Figure 1. Correlation matrix for monthly data

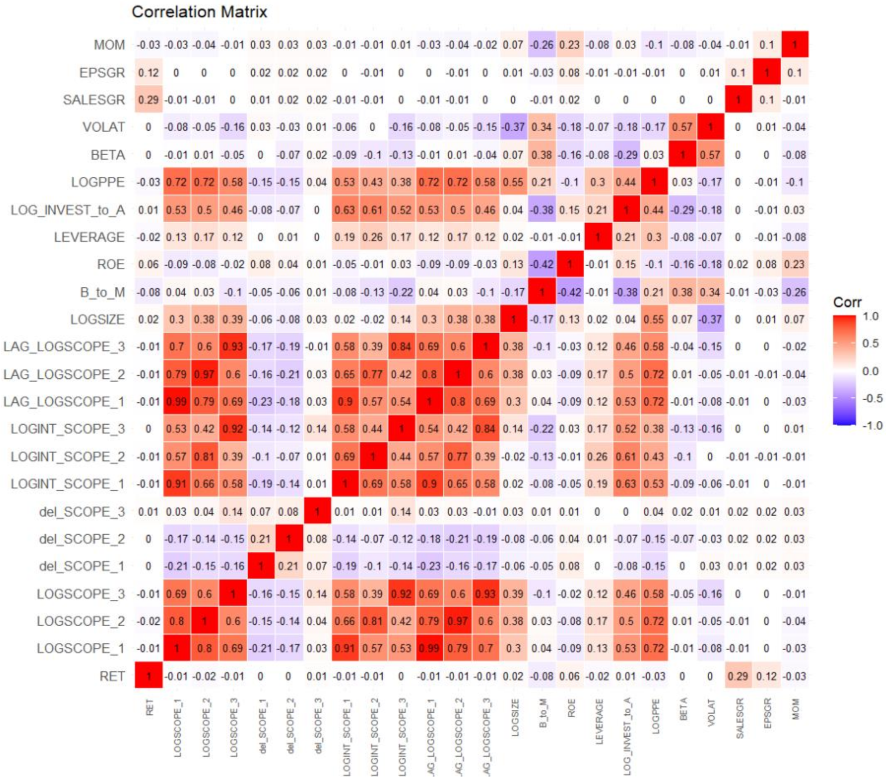
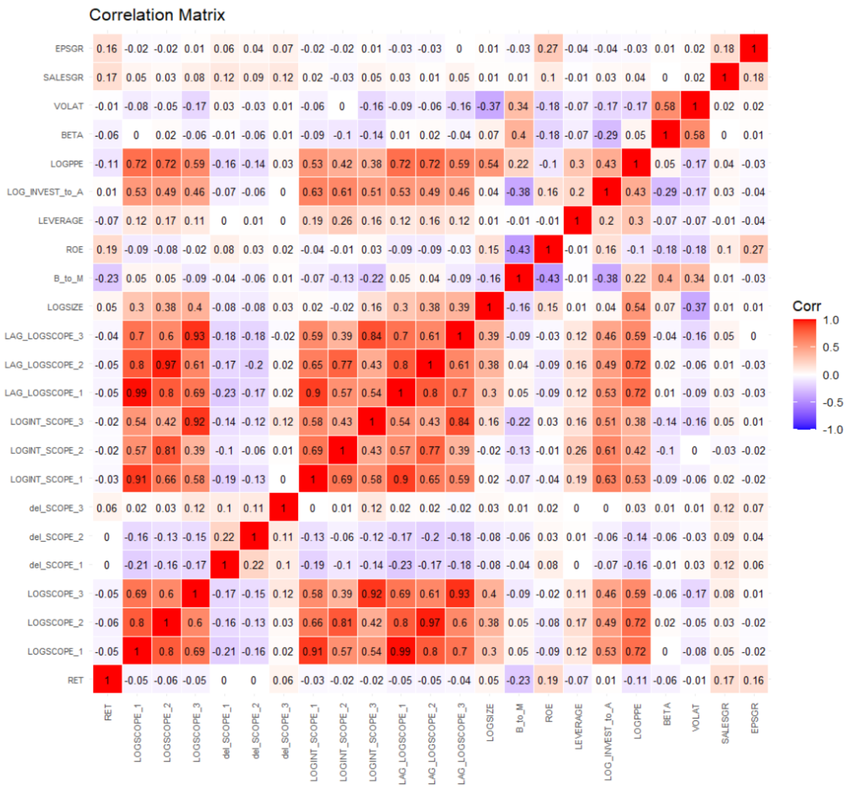


Figure 2. Correlation matrix for yearly data



Regressions should also be tested for autocorrelation and heteroscedasticity in the residuals. Autocorrelation occurs when there are correlations between the residuals, which is very common for the time-series data. Heteroscedasticity refers to a situation where the variance of the residuals is not constant. Both issues violate the regression assumptions about the residuals.

Multicollinearity for stock returns' regression is tested in R using the Generalized Variance Inflation Index (GVIF) (Fox and Monette, 1992, p. 180). If R is a correlation matrix, R_{11} is a correlation matrix of a set of variables for which GVIF is calculated and R_{22} is a correlation matrix excluding previously mentioned variables, then:

$$GVIF = \frac{detR_{11} \times detR_{22}}{detR}$$

In R, the normalized version $GVIF^{1/2Df}$ is used, where Df are degrees of freedom (e. g., the number of levels in the factor). Depending on the context, values larger than 2 may point to multicollinearity, but we set 3 as an acceptable level.

Autocorrelation is tested in all regressions by the Ljung-Box test for autocorrelation (Ljung and Box, 1978, p. 298). The test statistic is following:

$$\widetilde{Q}\,(\hat{r}) = n(n+2)\sum_{k=1}^{m}(n-k)^{-1}\,\hat{r}_k^2,$$

where $\hat{r}_k$ is a sample autocorrelation at lag k and m is the number of lags to test. The null hypothesis states that the residuals are uncorrelated.

Heteroscedasticity in all regressions is assessed using the Breusch-Pagan test for heteroscedasticity (Breusch and Pagan, 1979, p. 1288). The test statistic is based on the coefficient of determination R^2 from the regression of the squared residuals on the independent variables. The null hypothesis in this test is that the residuals are homoscedastic.

We construct a user-defined function in R to calculate both test statistics and automatically adjust the variance-covariance matrix to be robust against autocorrelation and/or heteroscedasticity for the regressions from the next section. Robust covariance matrices were calculated for all regressions, where needed. Generalized variance inflation factor was also checked for return regressions and is below the threshold for all variables.

Results

Firstly, we regress yearly CO_2 emissions variables on the controls and define the determinants of emissions. The coefficients are presented in the Table 7.

Table 7. CO_2 emissions regressions coefficients[2]

Logarithms of Scope 1, 2 and 3 emissions' levels			
Variable	**LOGSCOPE_1**	**LOGSCOPE_2**	**LOGSCOPE_3**
(Intercept)	-10.159*** (p = 0.000)	-6.582*** (p = 0.000)	-14.924*** (p = 0.000)
LOGSIZE	0.101** (p = 0.007)	0.150*** (p = 0.000)	0.489*** (p = 0.000)
B_to_M	0.461*** (p = 0.000)	0.190** (p = 0.005)	0.129 (p = 0.337)
ROE	-0.187 (p = 0.210)	-0.340* (p = 0.017)	-0.429 (p = 0.125)
LEVERAGE	-0.013*** (p = 0.000)	0.000 (p = 0.890)	-0.001 (p = 0.837)
LOG_INVEST_to_A	-0.007 (p = 0.818)	0.150*** (p = 0.000)	-0.304*** (p = 0.000)
LOGPPE	0.912*** (p = 0.000)	0.729*** (p = 0.000)	0.713*** (p = 0.000)
SALESGR	-0.152* (p = 0.045)	-0.112 (p = 0.122)	0.219 (p = 0.121)
EPSGR	0.335 (p = 0.415)	0.479 (p = 0.224)	0.803 (p = 0.294)
Sign. Industry FE	Yes	Yes	Yes
Sign. Country FE	Yes	Yes	No
Adjusted R^2	0.8593	0.7449	0.6457
Changes in emissions			
Variable	**del_SCOPE_1**	**del_SCOPE_2**	**del_SCOPE_3**
(Intercept)	2372691.054*** (p = 0.000)	462069.728*** (p = 0.000)	-10375546.850. (p = 0.065)
LOGSIZE	-66895.816. (p = 0.069)	-4254.806 (p = 0.566)	327685.022 (p = 0.366)
B_to_M	-63208.742 (p = 0.363)	-9874.342 (p = 0.482)	161585.295 (p = 0.813)
ROE	87408.060 (p = 0.542)	-31434.234 (p = 0.279)	-153136.347 (p = 0.914)
LEVERAGE	4485.029* (p = 0.013)	287.899 (p = 0.432)	5202.432 (p = 0.773)
LOG_INVEST_to_A	19026.369 (p = 0.523)	9603.090 (p = 0.111)	-314387.458 (p = 0.267)
LOGPPE	-21722.238 (p = 0.450)	-12658.741* (p = 0.029)	218329.597 (p = 0.450)
SALESGR	564802.566*** (p = 0.000)	82324.889*** (p = 0.000)	4021180.155*** (p = 0.000)
EPSGR	719374.017. (p = 0.070)	142597.914. (p = 0.076)	6910209.350. (p = 0.072)
Sign. Industry FE	Yes	Yes	No
Sign. Country FE	Yes	Yes	No
Adjusted R^2	0.1505	0.06414	0.00928
Logarithms of emission intensity (normalized by sales)			
Variable	**LOGINT_SCOPE_1**	**LOGINT_SCOPE_2**	**LOGINT_SCOPE_3**
(Intercept)	-13.030*** (p = 0.000)	-13.054*** (p = 0.000)	-17.745*** (p = 0.000)

[2] Significance levels: *** – 0.001, ** – 0.01, * - 0.05, . – 0.1.

LOGSIZE	-0.319*** (p = 0.000)	-0.309*** (p = 0.000)	0.049 (p = 0.488)
B_to_M	0.092 (p = 0.165)	0.096 (p = 0.145)	-0.266* (p = 0.047)
ROE	-0.091 (p = 0.507)	-0.094 (p = 0.494)	-0.224 (p = 0.422)
LEVERAGE	-0.006** (p = 0.001)	-0.005** (p = 0.002)	0.005 (p = 0.120)
LOG_INVEST_to_A	0.134*** (p = 0.000)	0.140*** (p = 0.000)	-0.165** (p = 0.003)
LOGPPE	0.460*** (p = 0.000)	0.452*** (p = 0.000)	0.273*** (p = 0.000)
SALESGR	-0.413*** (p = 0.000)	-0.418*** (p = 0.000)	-0.042 (p = 0.767)
EPSGR	0.645. (p = 0.089)	0.679. (p = 0.074)	0.978 (p = 0.202)
Sign. Industry FE	Yes	Yes	Yes
Sign. Country FE	Yes	Yes	No
Adjusted R^2	0.8248	0.8254	0.5248

Changes in emissions are positively associated with sales growth. However, higher sales growth leads to lower emission intensity (except for Scope 3). The same trend applies to company size: larger companies generate more emissions, but their emission intensity per dollar earned is lower. Companies with higher property, plant, and equipment produce more emissions. An increasing book-to-market value is associated with higher direct emissions (Scope 1 and 2) but lower Scope 3 intensity. In summary, larger companies with significant assets tend to produce more emissions overall, but they are more CO2-efficient in terms of their production and supply chains. Companies actively reinvesting in their business produce more Scope 1 and 2 emissions but reduce Scope 3 emissions, indicating a growing focus on the environmental practices of their supply chain providers.

Earnings per share growth does not influence emissions. Changes in emissions are mostly unrelated to financial indicators. Industry plays an important role in determining all types of emissions, while country-specific factors significantly affect Scope 1 and 2 emissions. The intercept is significantly positive for differences in emissions and negative for the levels and emission intensity.

Further, we should check whether CO2 emissions affect stock returns. The results of the regressions are presented in Table 8 and Table 9.

Table 8. Stock returns regressions coefficients (yearly)

Yearly data												
Variable	**LOGSCOPE_1**	**LOGSCOPE_2**	**LOGSCOPE_3**	**del_SCOPE_1**	**del_SCOPE_2**	**del_SCOPE_3**	**LOGINT_SCOPE_1**	**LOGINT_SCOPE_2**	**LOGINT_SCOPE_3**	**LAG_LOGSCOPE_1**	**LAG_LOGSCOPE_2**	**LAG_LOGSCOPE_3**
(Intercept)	-0.500*** (p = 0.000)	-0.477*** (p = 0.000)	-0.501*** (p = 0.000)	-0.525*** (p = 0.000)	-0.565*** (p = 0.000)	-0.513*** (p = 0.000)	-0.413** (p = 0.001)	-0.401** (p = 0.001)	-0.480*** (p = 0.000)	-0.538*** (p = 0.000)	-0.549*** (p = 0.000)	-0.616*** (p = 0.000)
CO2	**-0.002 (p = 0.427)**	**0.000 (p = 0.978)**	**-0.005* (p = 0.012)**	**0.000. (p = 0.064)**	**0.000* (p = 0.022)**	**0.000 (p = 0.114)**	**0.005 (p = 0.133)**	**0.008* (p = 0.020)**	**-0.002 (p = 0.221)**	**-0.001 (p = 0.823)**	**0.002 (p = 0.566)**	**-0.005* (p = 0.013)**
LOGSIZE	0.039*** (p = 0.000)	0.038*** (p = 0.000)	0.046*** (p = 0.000)	0.043*** (p = 0.000)	0.043*** (p = 0.000)	0.050*** (p = 0.000)	0.041*** (p = 0.000)	0.040*** (p = 0.000)	0.044*** (p = 0.000)	0.044*** (p = 0.000)	0.043*** (p = 0.000)	0.054*** (p = 0.000)
B_to_M	-0.129*** (p = 0.000)	-0.131*** (p = 0.000)	-0.115*** (p = 0.000)	-0.124*** (p = 0.000)	-0.124*** (p = 0.000)	-0.110*** (p = 0.000)	-0.131*** (p = 0.000)	-0.130*** (p = 0.000)	-0.117*** (p = 0.000)	-0.117*** (p = 0.000)	-0.118*** (p = 0.000)	-0.105*** (p = 0.000)
LEVERAGE	-0.001* (p = 0.031)	-0.001* (p = 0.042)	-0.001. (p = 0.073)	-0.001 (p = 0.134)	-0.001 (p = 0.130)	-0.001. (p = 0.081)	-0.001* (p = 0.043)	-0.001* (p = 0.029)	-0.001. (p = 0.078)	-0.001. (p = 0.086)	-0.001 (p = 0.111)	-0.001 (p = 0.136)
LOG_INVEST_to_A	-0.002 (p = 0.663)	-0.003 (p = 0.542)	-0.003 (p = 0.648)	-0.002 (p = 0.666)	-0.003 (p = 0.600)	0.000 (p = 0.936)	-0.003 (p = 0.561)	-0.006 (p = 0.294)	-0.002 (p = 0.738)	-0.004 (p = 0.504)	-0.004 (p = 0.489)	-0.004 (p = 0.522)
ROE	0.066* (p = 0.015)	0.060* (p = 0.028)	0.059* (p = 0.044)	0.065* (p = 0.018)	0.066* (p = 0.016)	0.056. (p = 0.066)	0.065* (p = 0.016)	0.060* (p = 0.026)	0.059* (p = 0.043)	0.071** (p = 0.007)	0.073** (p = 0.006)	0.066* (p = 0.023)
LOGPPE	-0.015* (p = 0.013)	-0.016** (p = 0.005)	-0.019** (p = 0.001)	-0.019** (p = 0.001)	-0.018** (p = 0.001)	-0.025*** (p = 0.000)	-0.019*** (p = 0.000)	-0.018** (p = 0.001)	-0.022*** (p = 0.000)	-0.019** (p = 0.001)	-0.019** (p = 0.001)	-0.022*** (p = 0.000)

BETA	-0.015 (p = 0.256)	-0.015 (p = 0.257)	-0.006 (p = 0.702)	-0.019 (p = 0.178)	-0.020 (p = 0.146)	-0.006 (p = 0.700)	-0.015 (p = 0.261)	-0.013 (p = 0.323)	-0.007 (p = 0.630)	-0.009 (p = 0.512)	-0.012 (p = 0.353)	0.000 (p = 0.993)
VOLAT	0.539*** (p = 0.000)	0.524*** (p = 0.000)	0.441*** (p = 0.000)	0.543*** (p = 0.000)	0.555*** (p = 0.000)	0.450*** (p = 0.000)	0.536*** (p = 0.000)	0.514*** (p = 0.000)	0.453*** (p = 0.000)	0.480*** (p = 0.000)	0.493*** (p = 0.000)	0.402*** (p = 0.000)
SALESGR	0.129*** (p = 0.000)	0.131*** (p = 0.000)	0.127*** (p = 0.000)	0.134*** (p = 0.000)	0.131*** (p = 0.000)	0.127*** (p = 0.000)	0.130*** (p = 0.000)	0.133*** (p = 0.000)	0.124*** (p = 0.000)	0.138*** (p = 0.000)	0.139*** (p = 0.000)	0.135*** (p = 0.000)
EPSGR	0.424*** (p = 0.000)	0.434*** (p = 0.000)	0.426*** (p = 0.000)	0.428*** (p = 0.000)	0.440*** (p = 0.000)	0.411*** (p = 0.000)	0.426*** (p = 0.000)	0.434*** (p = 0.000)	0.431*** (p = 0.000)	0.398*** (p = 0.000)	0.415*** (p = 0.000)	0.399*** (p = 0.000)
Sign. Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sign. Country FE	No	Yes	No	No	No	No	No	No	No	No	No	No
Adjusted R^2	0.1349	0.1337	0.1245	0.136	0.1346	0.1263	0.1356	0.1353	0.1235	0.1342	0.1323	0.129

Table 9. Stock returns regressions coefficients (monthly)

Monthly data												
Variable	**LOGSCOPE_1**	**LOGSCOPE_2**	**LOGSCOPE_3**	**del_SCOPE_1**	**del_SCOPE_2**	**del_SCOPE_3**	**LOGINT_SCOPE_1**	**LOGINT_SCOPE_2**	**LOGINT_SCOPE_3**	**LAG_LOGSCOPE_1**	**LAG_LOGSCOPE_2**	**LAG_LOGSCOPE_3**
(Intercept)	-0.078*** (p = 0.000)	-0.077*** (p = 0.000)	-0.065*** (p = 0.000)	-0.081*** (p = 0.000)	-0.082*** (p = 0.000)	-0.073*** (p = 0.000)	-0.064*** (p = 0.000)	-0.066*** (p = 0.000)	-0.060*** (p = 0.000)	-0.082*** (p = 0.000)	-0.080*** (p = 0.000)	-0.084*** (p = 0.000)

CO2	**0.000 (p = 0.285)**	**0.000 (p = 0.189)**	**0.000 (p = 0.541)**	**0.000 (p = 0.400)**	**0.000 (p = 0.126)**	**0.000 (p = 0.216)**	**0.001* (p = 0.031)**	**0.001* (p = 0.042)**	**0.000 (p = 0.245)**	**0.000 (p = 0.260)**	**0.000 (p = 0.441)**	**-0.001** (p = 0.004)**
LOGSIZE	0.004*** (p = 0.000)	0.004*** (p = 0.000)	0.005*** (p = 0.000)	0.005*** (p = 0.000)	0.005*** (p = 0.000)	0.006*** (p = 0.000)	0.005*** (p = 0.000)	0.004*** (p = 0.000)	0.005*** (p = 0.000)	0.005*** (p = 0.000)	0.005*** (p = 0.000)	0.006*** (p = 0.000)
B_to_M	-0.016*** (p = 0.000)	-0.016*** (p = 0.000)	-0.015*** (p = 0.000)	-0.015*** (p = 0.000)	-0.016*** (p = 0.000)	-0.016*** (p = 0.000)	-0.016*** (p = 0.000)	-0.016*** (p = 0.000)	-0.016*** (p = 0.000)	-0.014*** (p = 0.000)	-0.015*** (p = 0.000)	-0.014*** (p = 0.000)
LEVERAGE	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)	0.000*** (p = 0.000)
MOM	-0.360*** (p = 0.000)	-0.357*** (p = 0.000)	-0.370*** (p = 0.000)	-0.369*** (p = 0.000)	-0.366*** (p = 0.000)	-0.388*** (p = 0.000)	-0.360*** (p = 0.000)	-0.357*** (p = 0.000)	-0.371*** (p = 0.000)	-0.354*** (p = 0.000)	-0.353*** (p = 0.000)	-0.364*** (p = 0.000)
LOG_INVEST_to_A	-0.002** (p = 0.003)	-0.001** (p = 0.003)	-0.002** (p = 0.004)	-0.002** (p = 0.003)	-0.002** (p = 0.002)	-0.002** (p = 0.005)	-0.002** (p = 0.002)	-0.002** (p = 0.001)	-0.002** (p = 0.003)	-0.001** (p = 0.007)	-0.001** (p = 0.005)	-0.002** (p = 0.004)
ROE	0.019*** (p = 0.000)	0.018*** (p = 0.000)	0.017*** (p = 0.000)	0.019*** (p = 0.000)	0.018*** (p = 0.000)	0.016*** (p = 0.000)	0.019*** (p = 0.000)	0.018*** (p = 0.000)	0.017*** (p = 0.000)	0.019*** (p = 0.000)	0.018*** (p = 0.000)	0.016*** (p = 0.000)
LOGPPE	-0.002** (p = 0.002)	-0.002** (p = 0.004)	-0.002*** (p = 0.000)	-0.002*** (p = 0.000)	-0.002*** (p = 0.000)	-0.003*** (p = 0.000)	-0.002*** (p = 0.000)	-0.002*** (p = 0.000)	-0.002*** (p = 0.000)	-0.002*** (p = 0.000)	-0.002** (p = 0.001)	-0.002*** (p = 0.000)
BETA	0.003* (p = 0.016)	0.003* (p = 0.010)	0.004** (p = 0.001)	0.003* (p = 0.033)	0.003* (p = 0.032)	0.004** (p = 0.001)	0.003* (p = 0.018)	0.003* (p = 0.012)	0.004** (p = 0.001)	0.003** (p = 0.005)	0.003** (p = 0.003)	0.005*** (p = 0.000)
VOLAT	0.059*** (p = 0.000)	0.056*** (p = 0.000)	0.039*** (p = 0.000)	0.059*** (p = 0.000)	0.058*** (p = 0.000)	0.040*** (p = 0.000)	0.058*** (p = 0.000)	0.056*** (p = 0.000)	0.040*** (p = 0.000)	0.051*** (p = 0.000)	0.048*** (p = 0.000)	0.032** (p = 0.001)
SALESGR	0.323*** (p = 0.000)	0.324*** (p = 0.000)	0.332*** (p = 0.000)	0.322*** (p = 0.000)	0.322*** (p = 0.000)	0.333*** (p = 0.000)	0.323*** (p = 0.000)	0.324*** (p = 0.000)	0.332*** (p = 0.000)	0.318*** (p = 0.000)	0.319*** (p = 0.000)	0.326*** (p = 0.000)
EPSGR	0.722*** (p = 0.000)	0.723*** (p = 0.000)	0.748*** (p = 0.000)	0.708*** (p = 0.000)	0.712*** (p = 0.000)	0.720*** (p = 0.000)	0.723*** (p = 0.000)	0.724*** (p = 0.000)	0.751*** (p = 0.000)	0.700*** (p = 0.000)	0.695*** (p = 0.000)	0.687*** (p = 0.000)

Sign. Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sign. Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sign. Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sign. Country FE	Yes	Yes	Yes	No	No	Yes	No	No	Yes	Yes	No	Yes

There is only a weak and unstable effect of CO_2 emissions on stock returns. The weak positive effect of Scope 2 emissions intensity and the negative effect of Scope 3 lagged emission levels are significant for both monthly and yearly data. However, other weak effects disappear when the data frequency is changed. The control variables are significant in all cases, and the intercept is negative.

Larger companies with higher ROE have higher returns. Book-to-market and MOM values have a negative effect, while leverage has a weak effect close to zero. Companies with higher investments tend to have lower returns, although this effect vanishes with frequency changes. Higher property, plant, and equipment values are associated with lower returns. Beta shows a weak positive effect, which also disappears with frequency changes.

Higher volatility, sales growth, and EPS growth are associated with higher returns. Industry effects are significant for both yearly and monthly data, while country effects are significant only for monthly data and not in all cases. Time effects are significant.

To sum up, the hypothesis that CO_2 emissions influence stock returns is not supported by this study.

Conclusion

This seminar paper investigates the relationship between financial indicators, stock returns, and CO2 emissions in the European market, adapting the methodology of Bolton and Kacperczyk (2021) but focusing on European market from 2010 to 2023. The study analyzes annual and monthly data, examining levels, growth rates, emission intensities and lagged emissions of Scope 1, 2, and 3 CO2 emissions, alongside continuous stock returns.

Key findings include:

- Larger companies produce more emissions overall but are relatively CO2-efficient in production and supply chains. Companies reinvesting in their business increase Scope 1 and 2 emissions while reducing Scope 3 emissions, reflecting supply chain improvements.
- Earnings per share growth shows no effect on emissions, and changes in emissions are mostly independent of financial indicators.
- Industry significantly influences all emission types, while country-specific factors mainly affect Scope 1 and 2 emissions.
- There is no consistent, significant effect of CO2 emissions on stock returns. While Scope 2 emission intensity and lagged Scope 3 emission levels show weak effects, these are not robust across different data frequencies.

The study concludes that the hypothesis of Bolton and Kacperczyk (2021) regarding a link between CO2 emissions and stock returns is not supported in the European context.

Further research can include the Asian stock market and searching for further determinants of carbon emissions.

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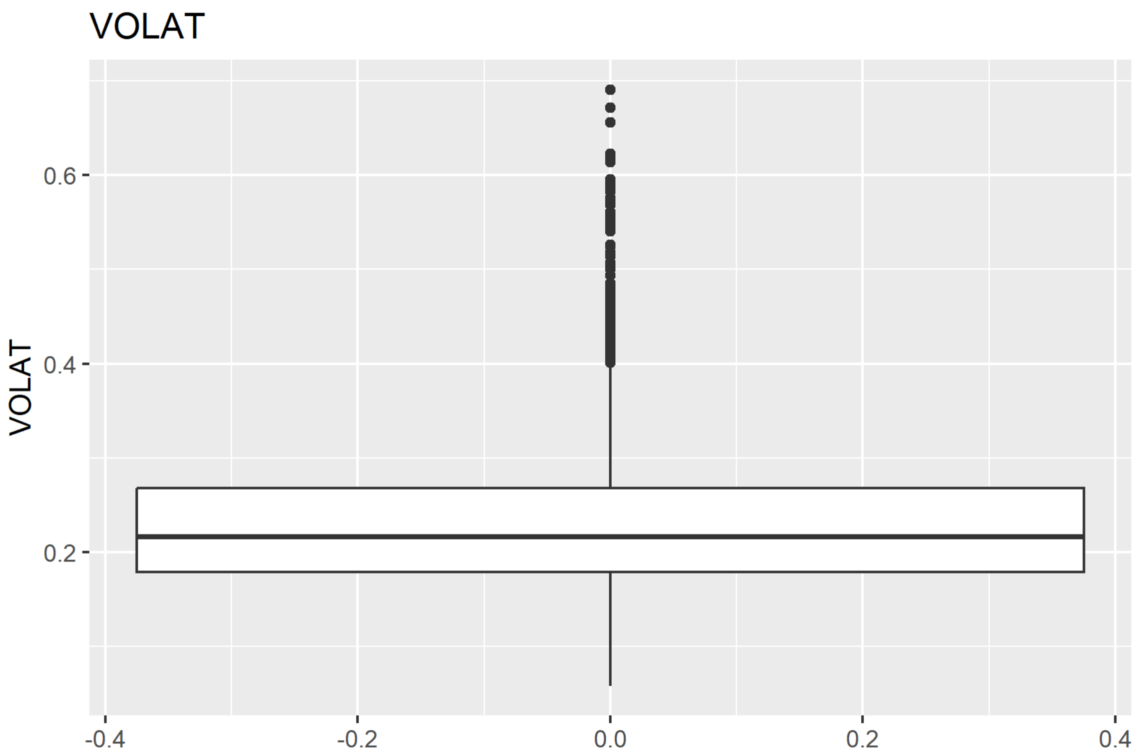
Appendix

Appendix 1: List of journals for literature review

Title	ISSN	Rating
The Journal of Finance	1540-6261	A+
American Economic Review (excluding Papers and Proceedings)	1944-7981	A+
Journal of Financial Economics	1879-2774	A+
The Review of Financial Studies	1465-7368	A+
Science	1095-9203	A+
Econometrica	1468-0262	A+
Journal of Political Economy	1537-534X	A+
Quarterly Journal of Economics	1531-4650	A+
Management Science	1526-5501	A+
The Accounting Review	1558-7967	A+
Journal of Accounting and Economics	1879-1980	A+
Review of Economic Studies	1467-937X	A+
Journal of Accounting Research	1475-679X	A+
Review of Finance	1573-692X	A
Journal of Financial and Quantitative Analysis	1756-6916	A
Review of Accounting Studies	1573-7136	A
The Economic Journal	1468-0297	A
Journal of Monetary Economics	1873-1295	A
Journal of Econometrics	0304-4076	A
The Review of Economics and Statistics	1530-9142	A
Journal of Banking and Finance	1872-6372	A
Journal of Economic Theory	1095-7235	A
Journal of Labor Economics	1537-5307	A
American economic journal: macroeconomics	1945-7715	A
American Economic Review: Insights	2640-2068	A
Journal of Financial Intermediation	1096-0473	A
American economic journal: microeconomics	1945-7685	A
The Review of Asset Pricing Studies	2045-9939	A
American economic journal: applied economics	1945-7790	A
Journal of Economic Literature	2328-8175	A
Journal of Economic Perspectives	1944-7965	A
Journal of Public Economics	1879-2316	A
Journal of the European Economic Association	1542-4774	A
Contemporary Accounting Research - Recherche Comptable Contemporaine	1911-3846	A
European Accounting Review	1468-4497	A
American Economic Journal: Economic Policy	1945-774X	A
Journal of Economic Behavior and Organization	1879-1751	A

Strategic Management Journal (SMJ)	1097-0266	A
Journal of Law and Economics	1537-5285	A
The RAND Journal of Economics	1756-2171	A
The Review of Corporate Finance Studies	2046-9136	A
Critical Finance Review	2164-5760	A
Journal of Corporate Finance	1872-6313	A
Journal of Money, Credit and Banking (JMCB)	1538-4616	A
Journal of Business	1537-5374	A
Accounting, Organizations and Society	1873-6289	A
Journal of Risk and Insurance	1539-6975	A
European Economic Review	1873-572X	A
Journal of International Economics	0022-1996	A
Review of Derivatives Research	1573-7144	A
International Economic Review	1468-2354	A
Journal of Economic Dynamics and Control	0165-1889	A
Journal of Financial Stability	1572-3089	A

Appendix 2: Box plots of variables before winsorizing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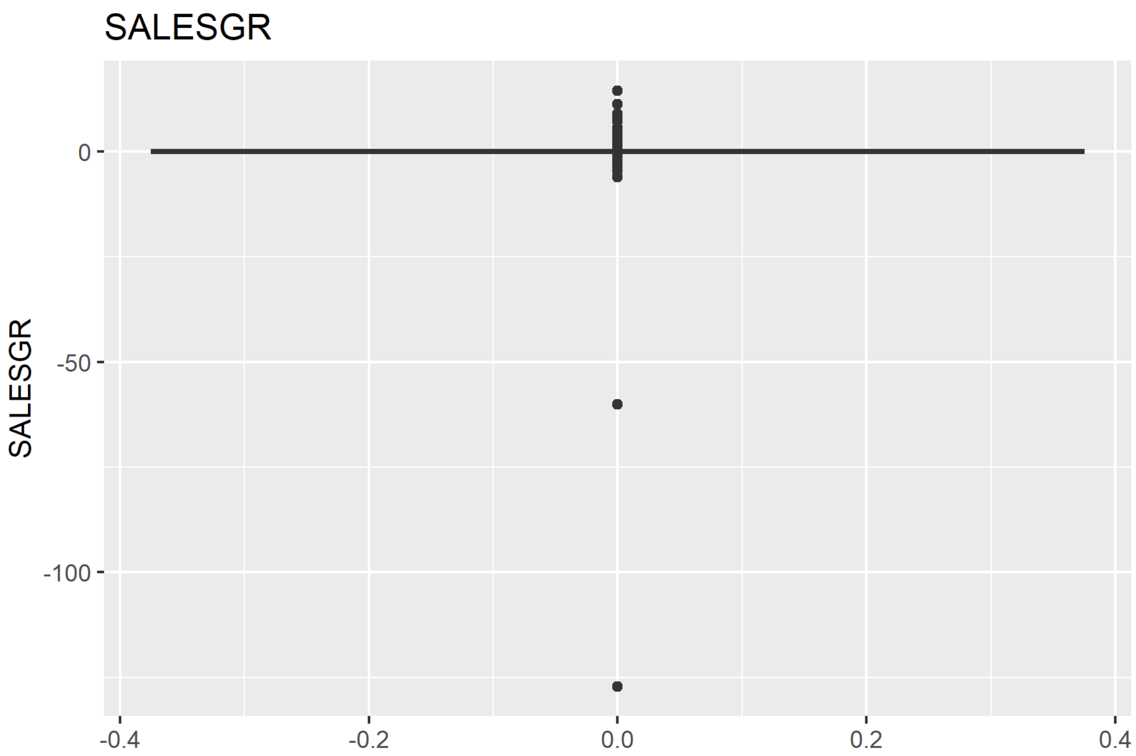
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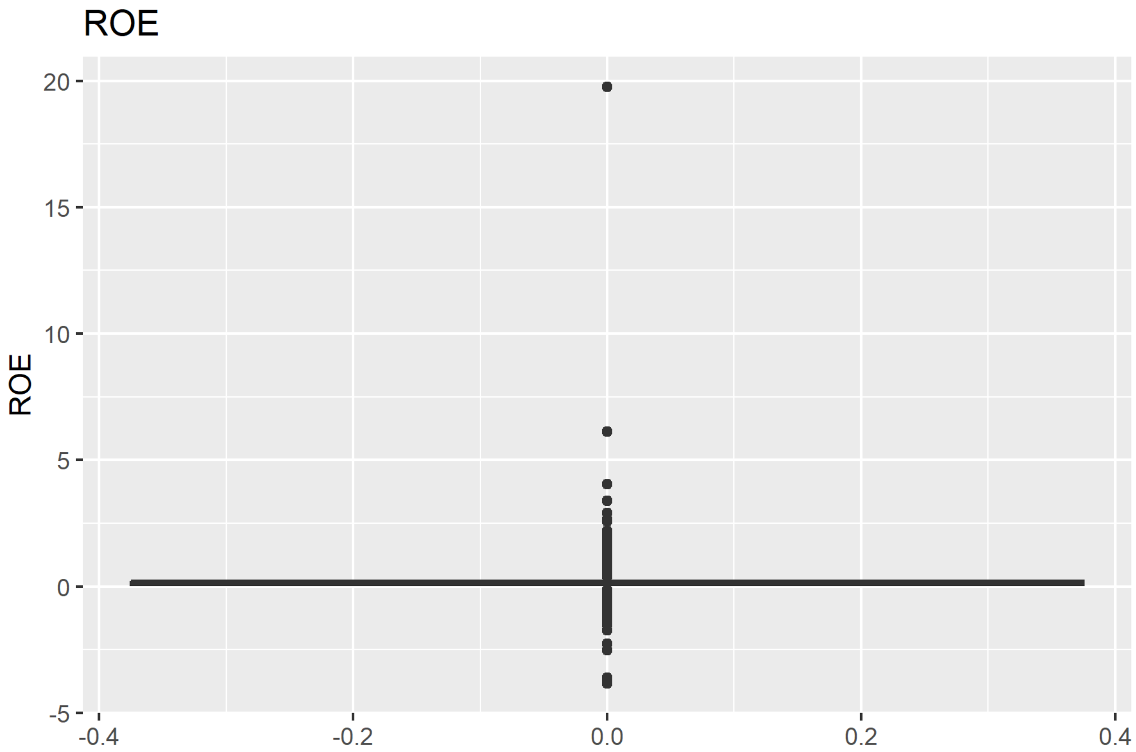
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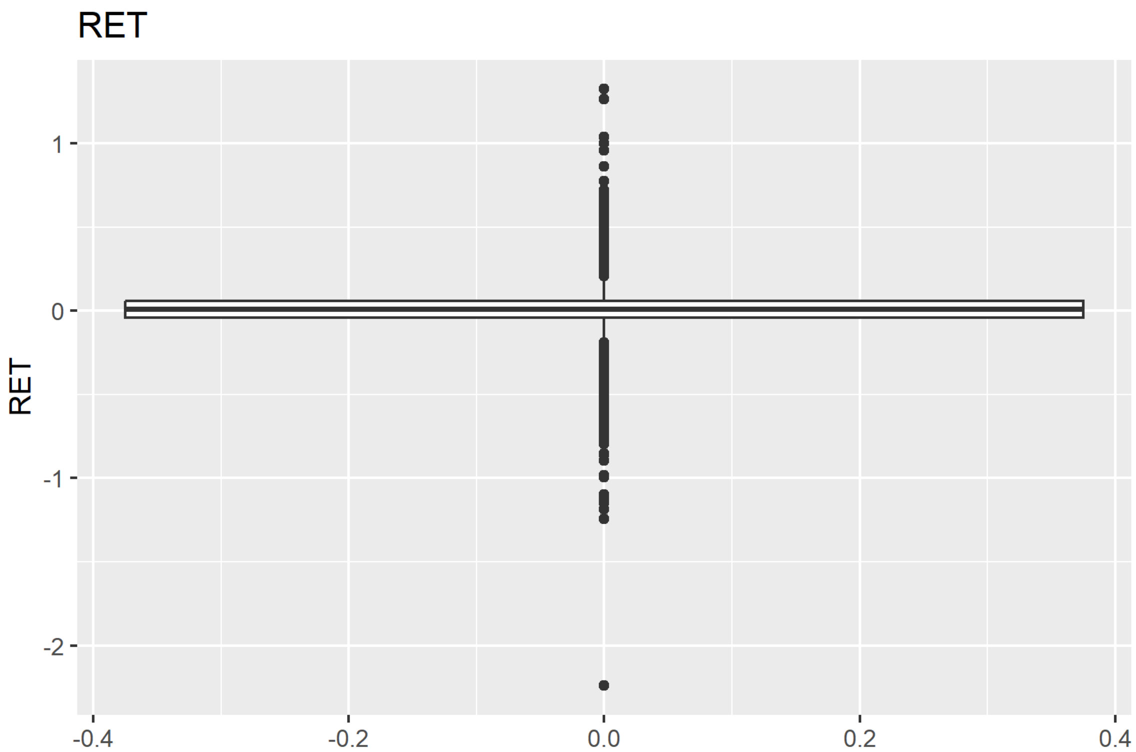
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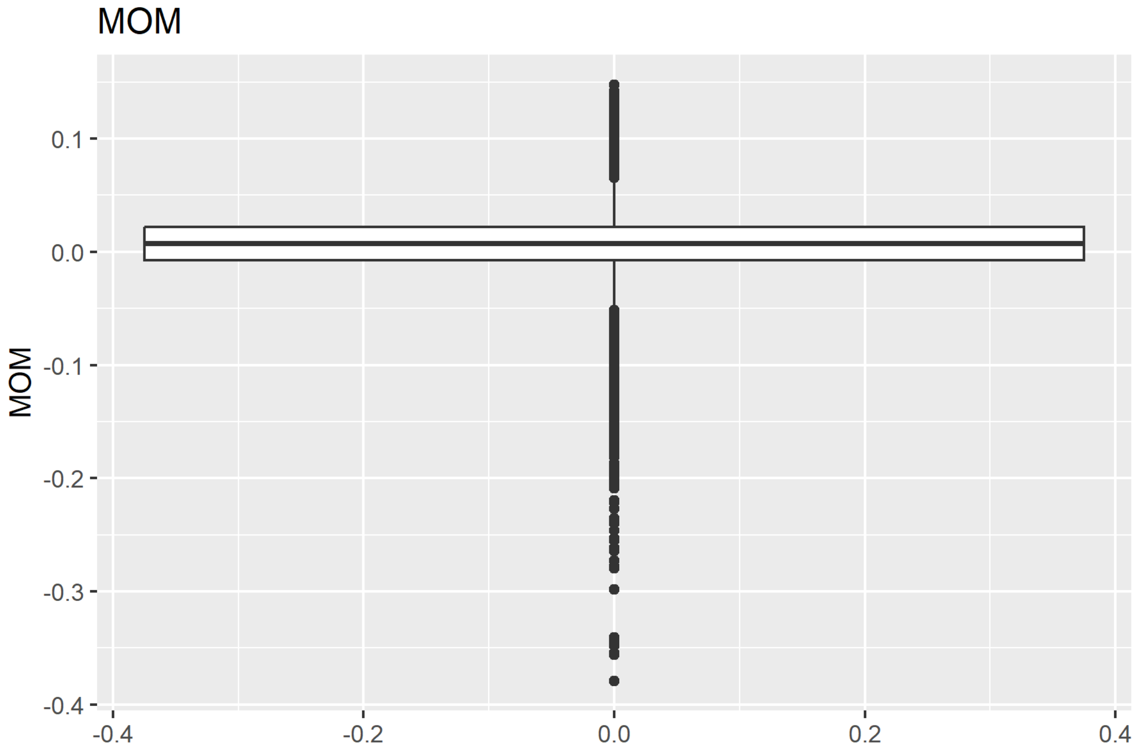
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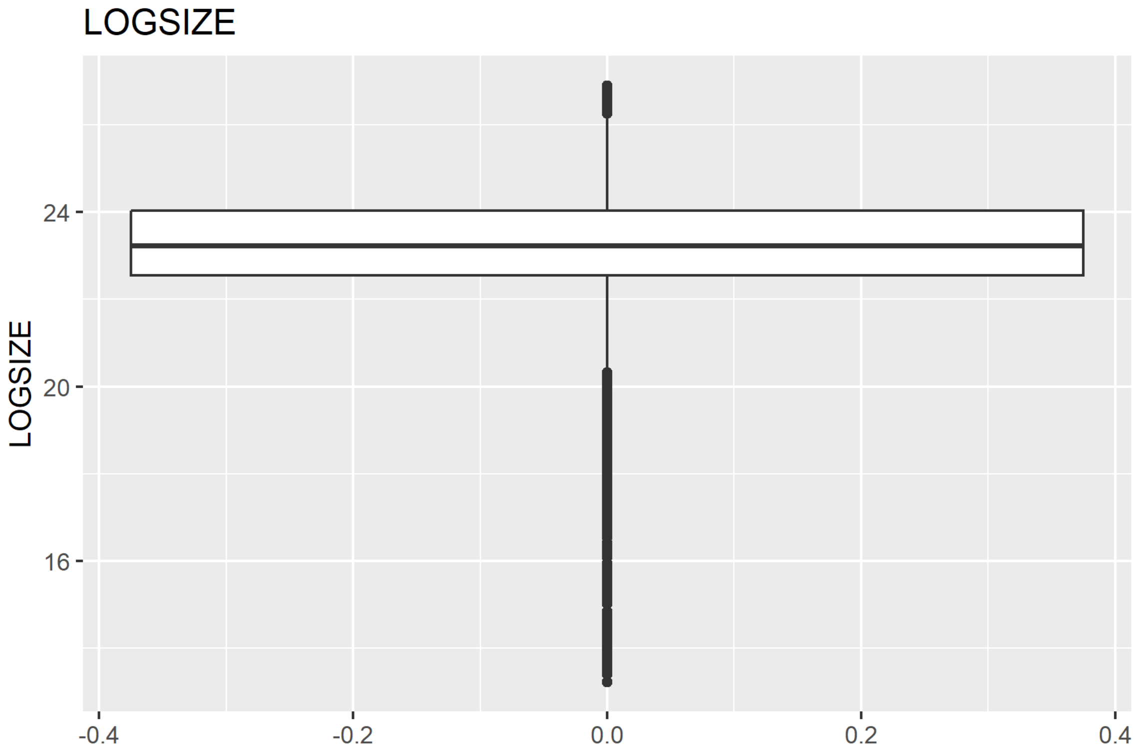
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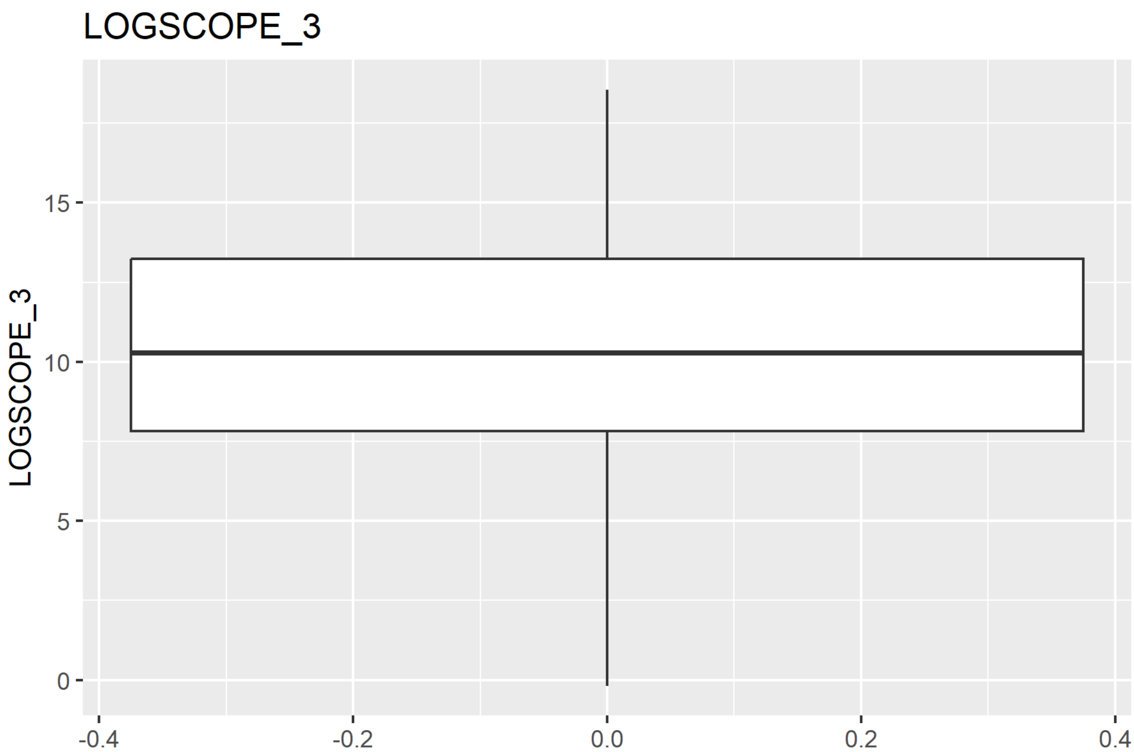
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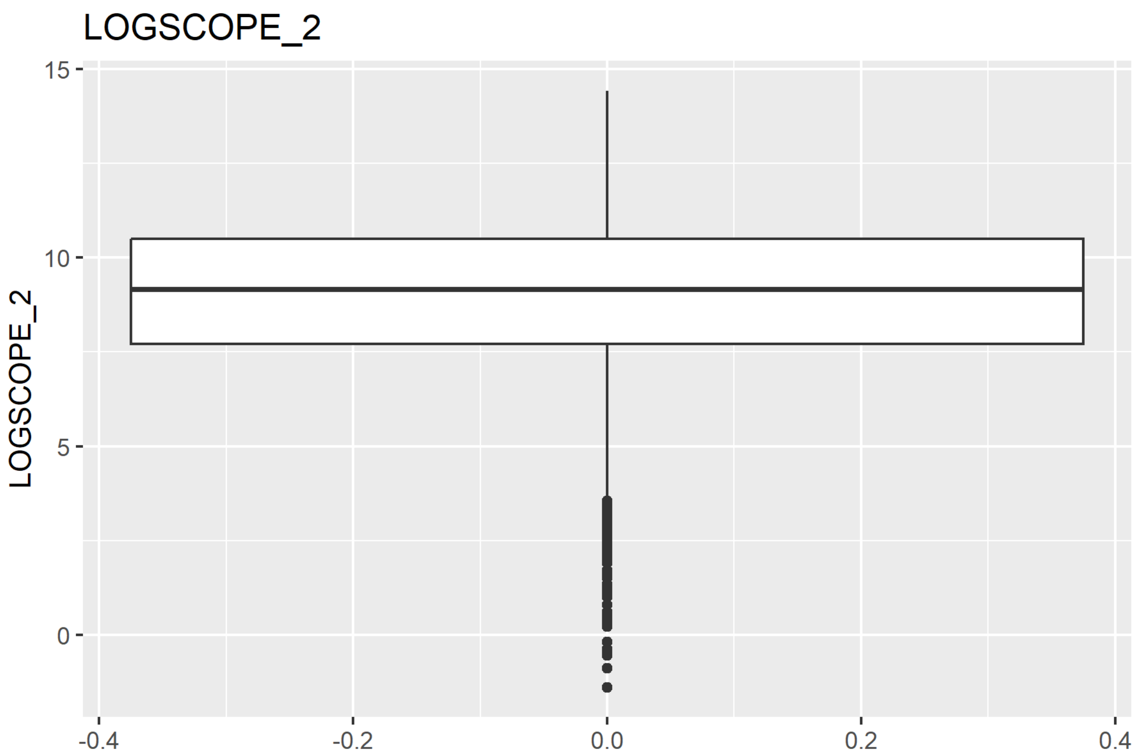
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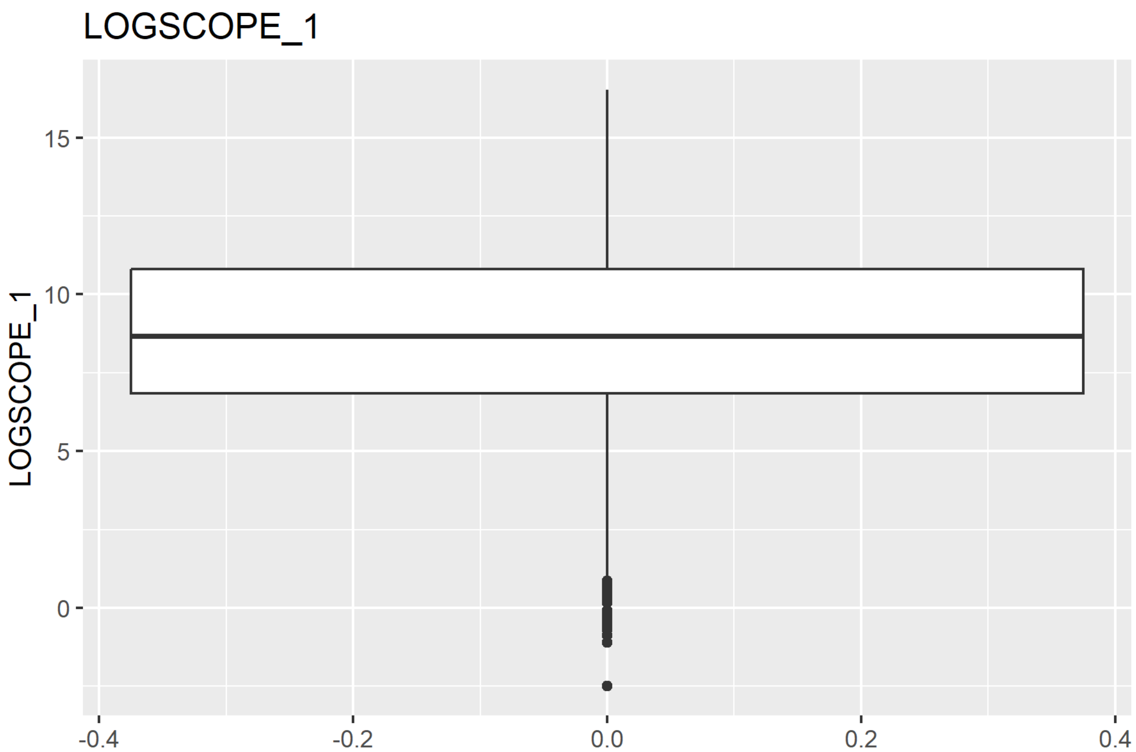
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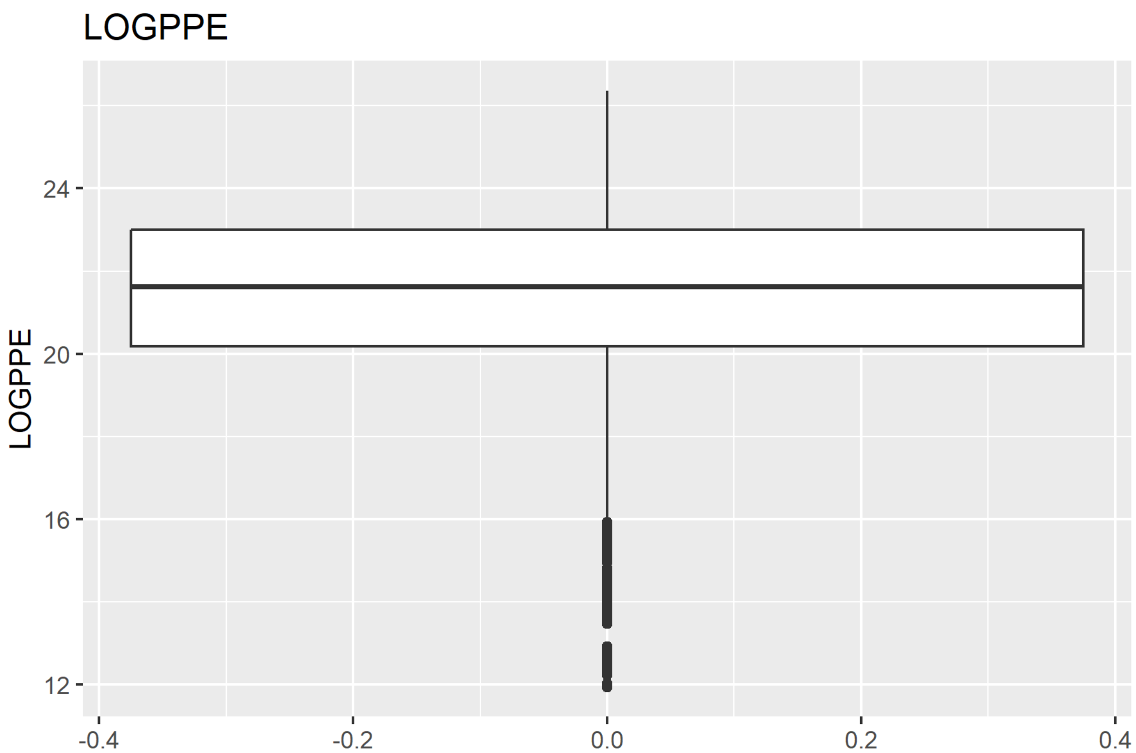
LOGPPE
LOGPPE
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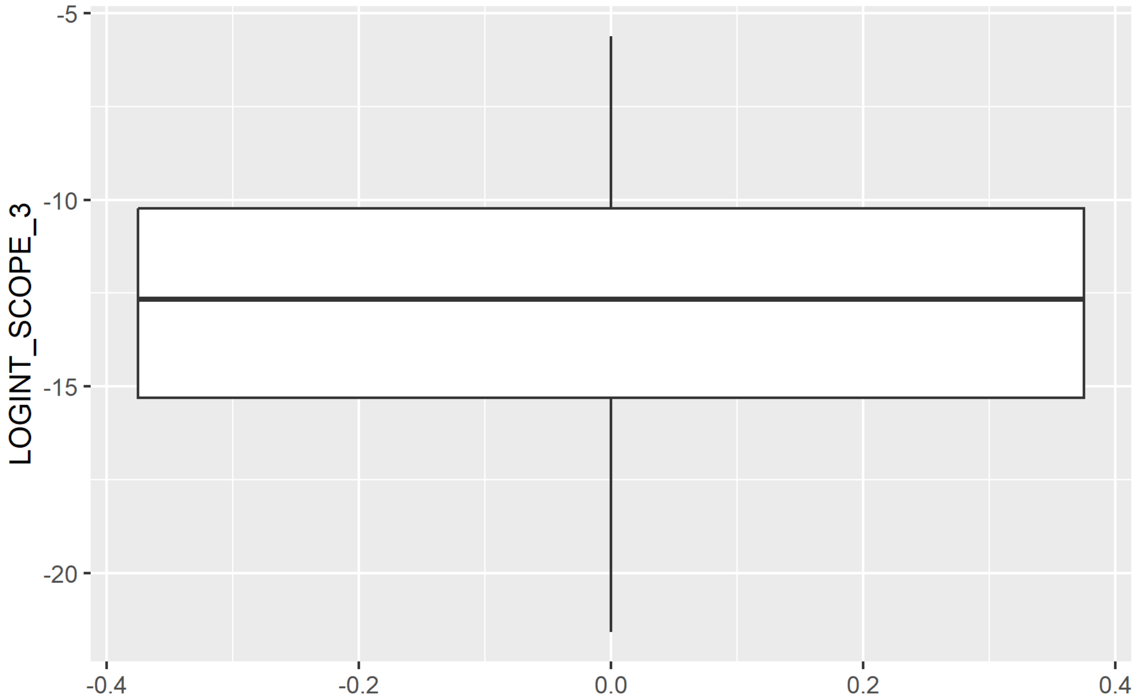
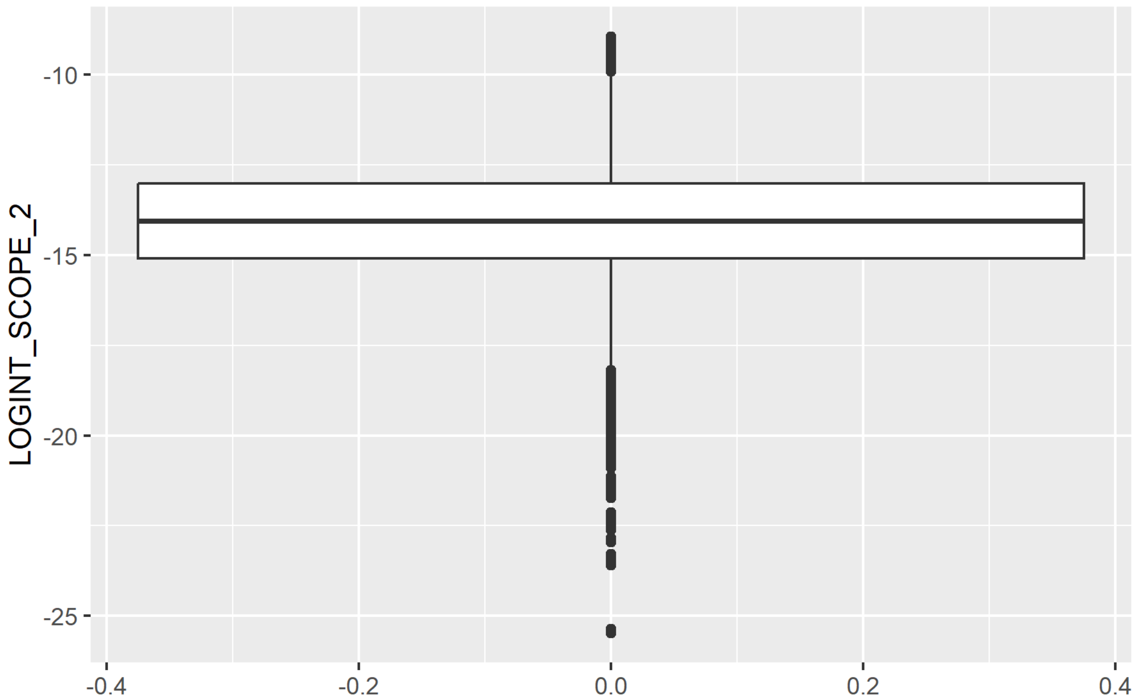
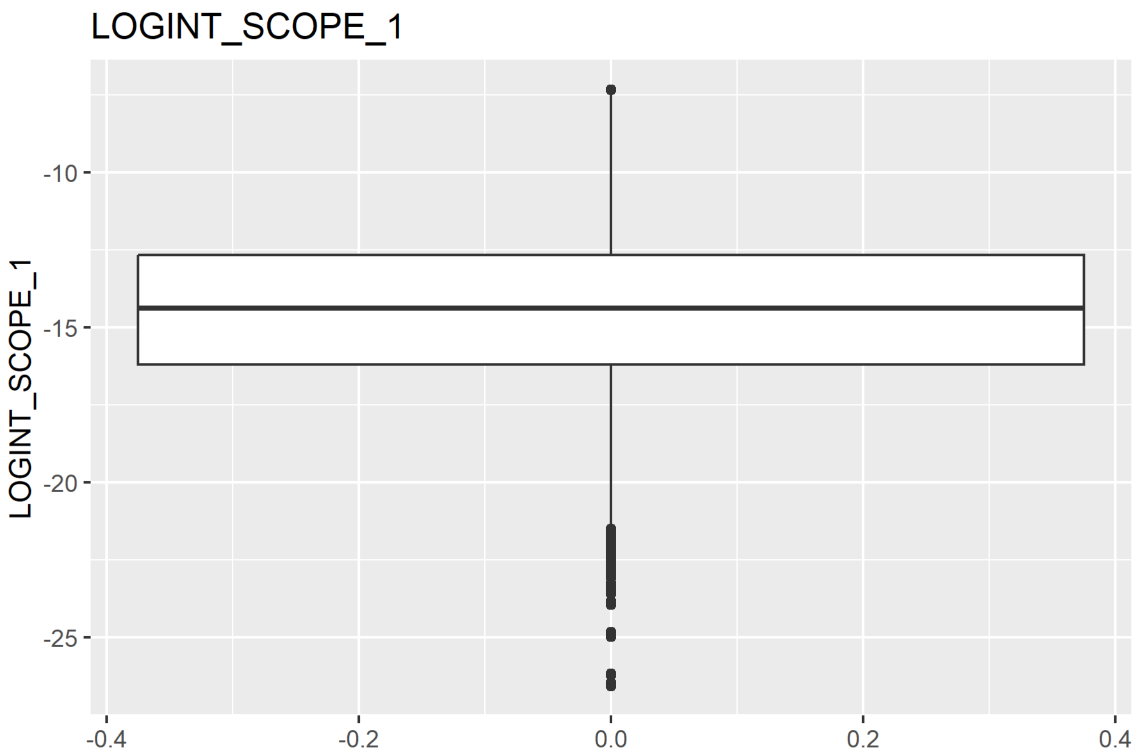
20
16
12
-0.4
-0.2
0.0
0.2
0.4

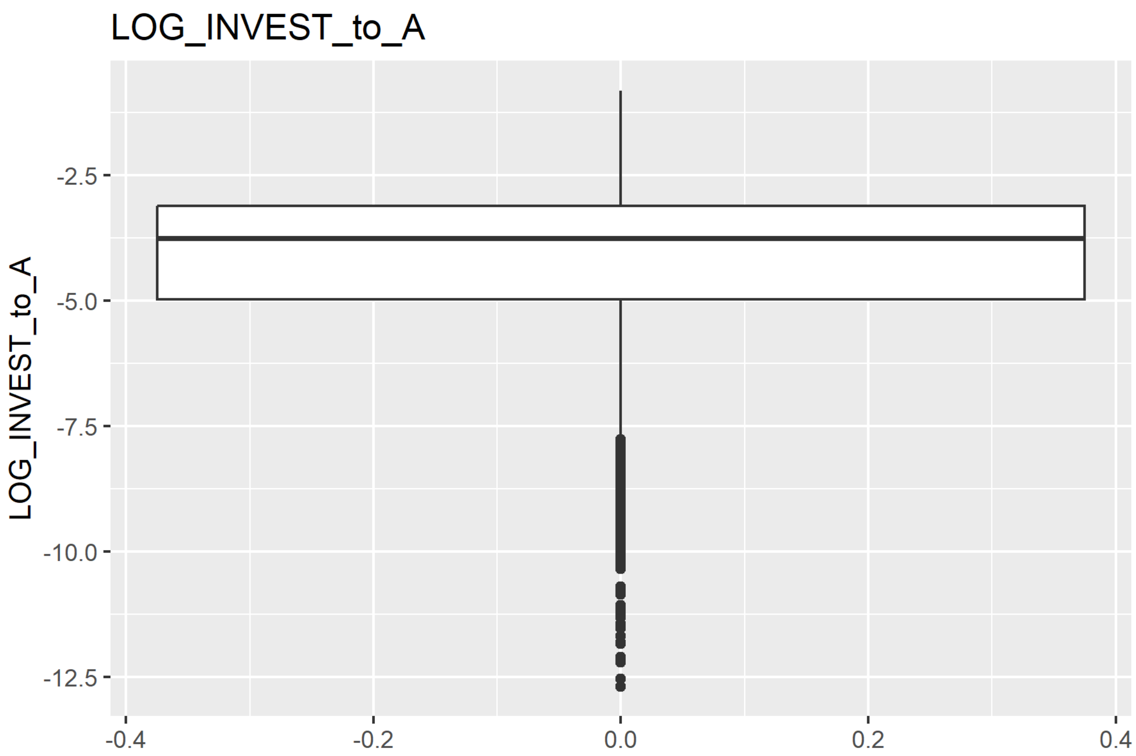
LOGINT_SCOPE_3

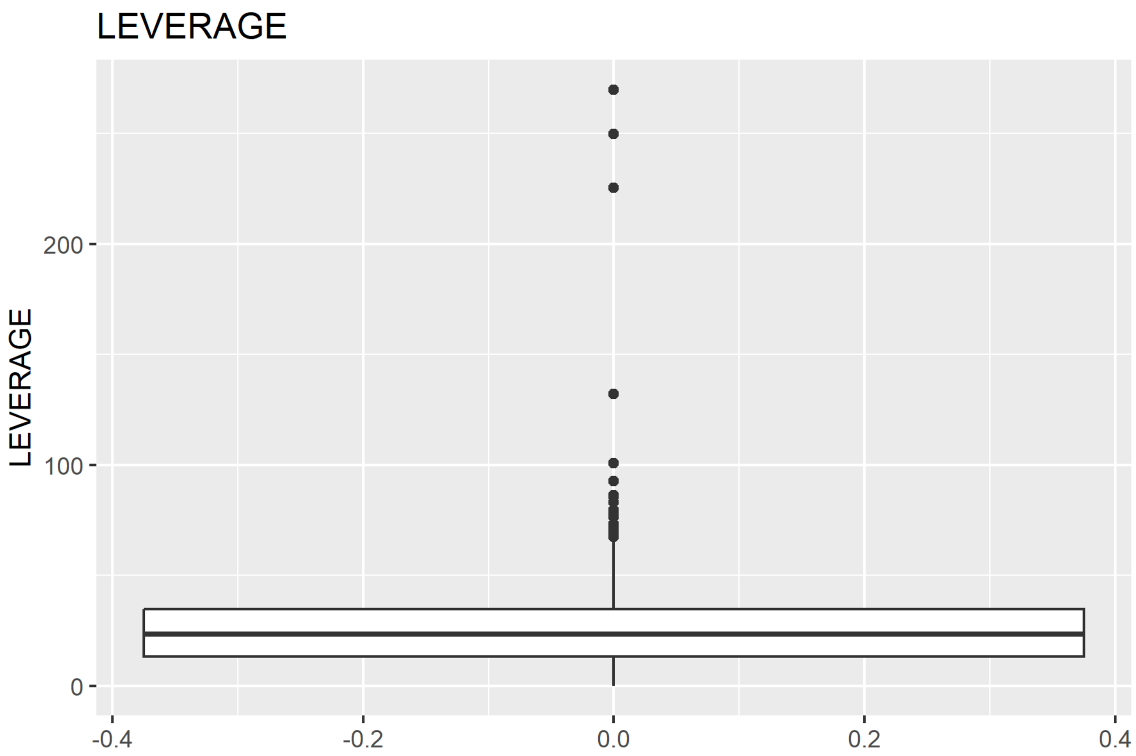


LOGINT_SCOPE_2




LOGINT_SCOPE_1
LOGINT_SCOPE_1
-10
-15
-20
-25
-0.4
-0.2
0.0
0.2
0.4


LOG_INVEST_to_A
LOG_INVEST_to_A
-2.5
-5.0
-7.5
-10.0
-12.5
-0.4
-0.2
0.0
0.2
0.4


LEVERAGE
LEVERAGE
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100
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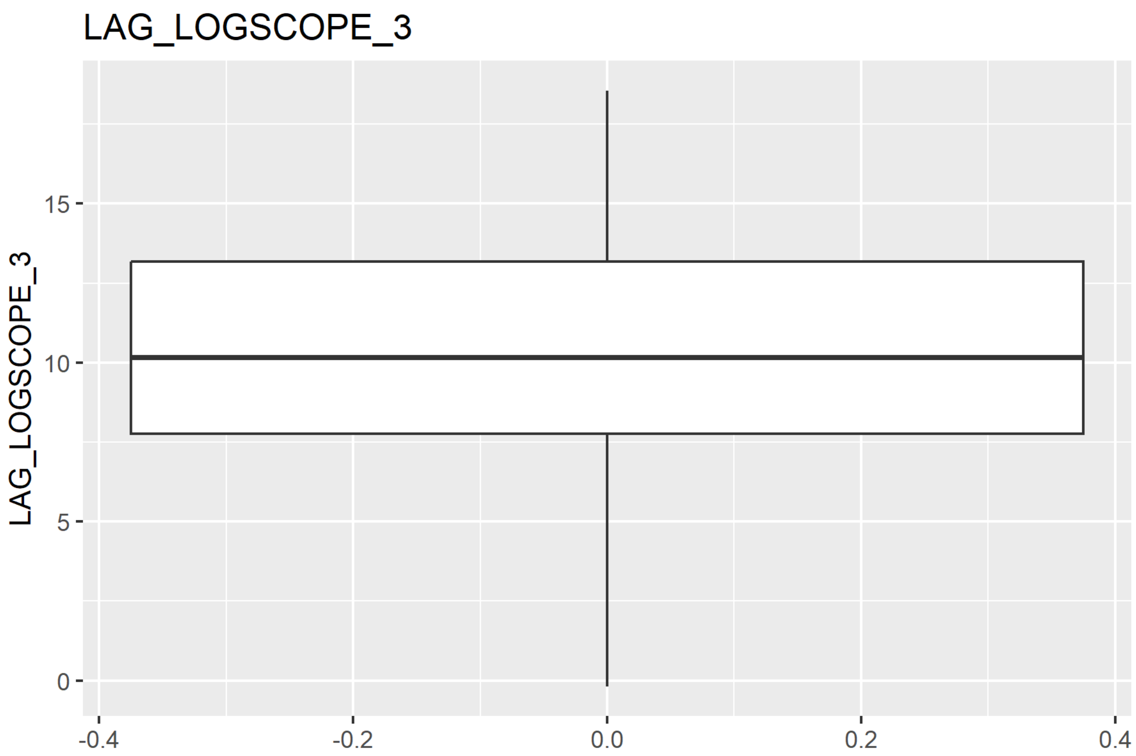
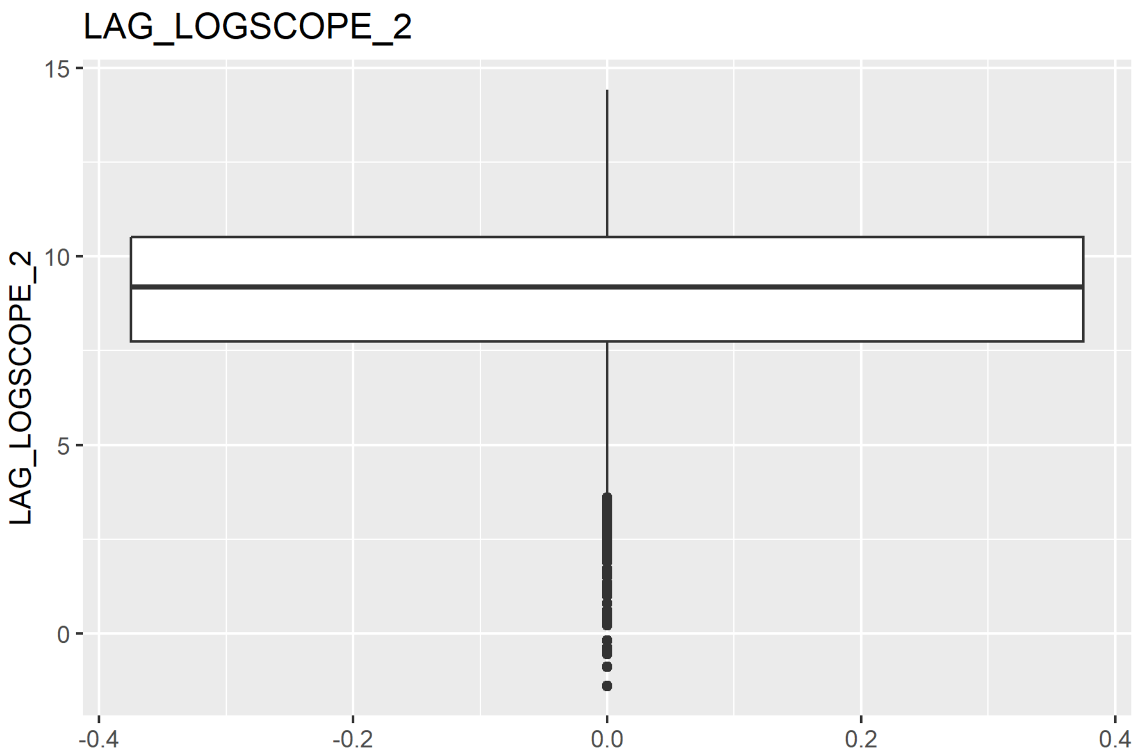
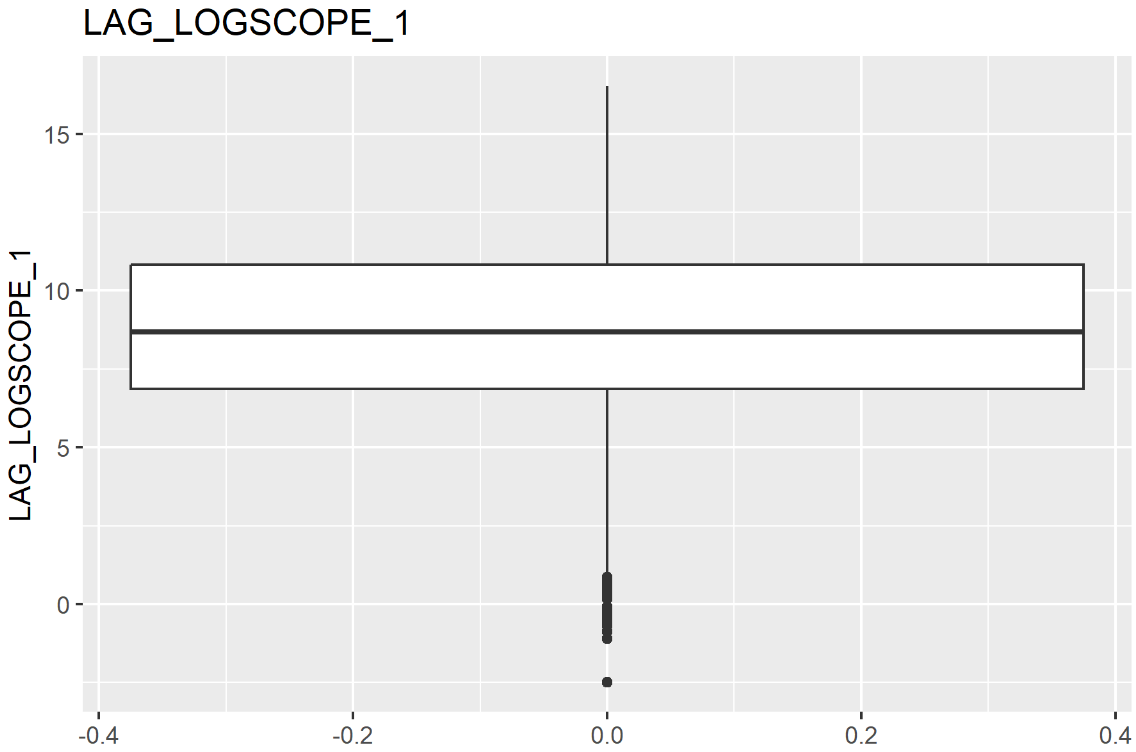
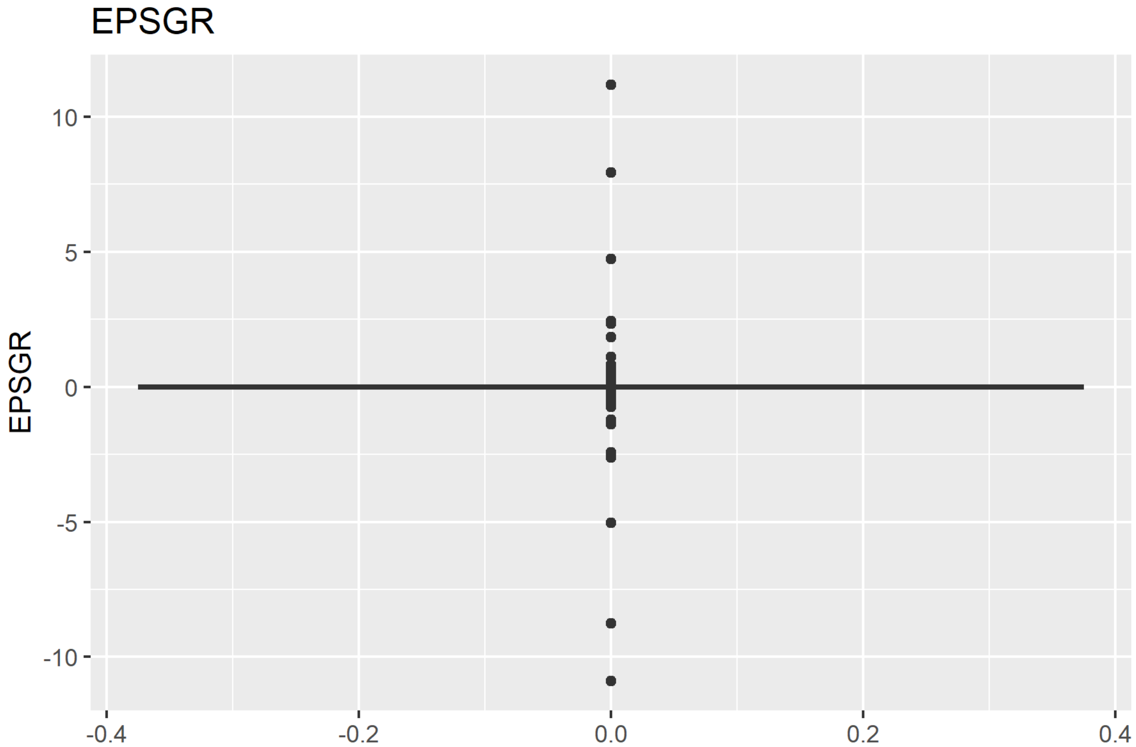
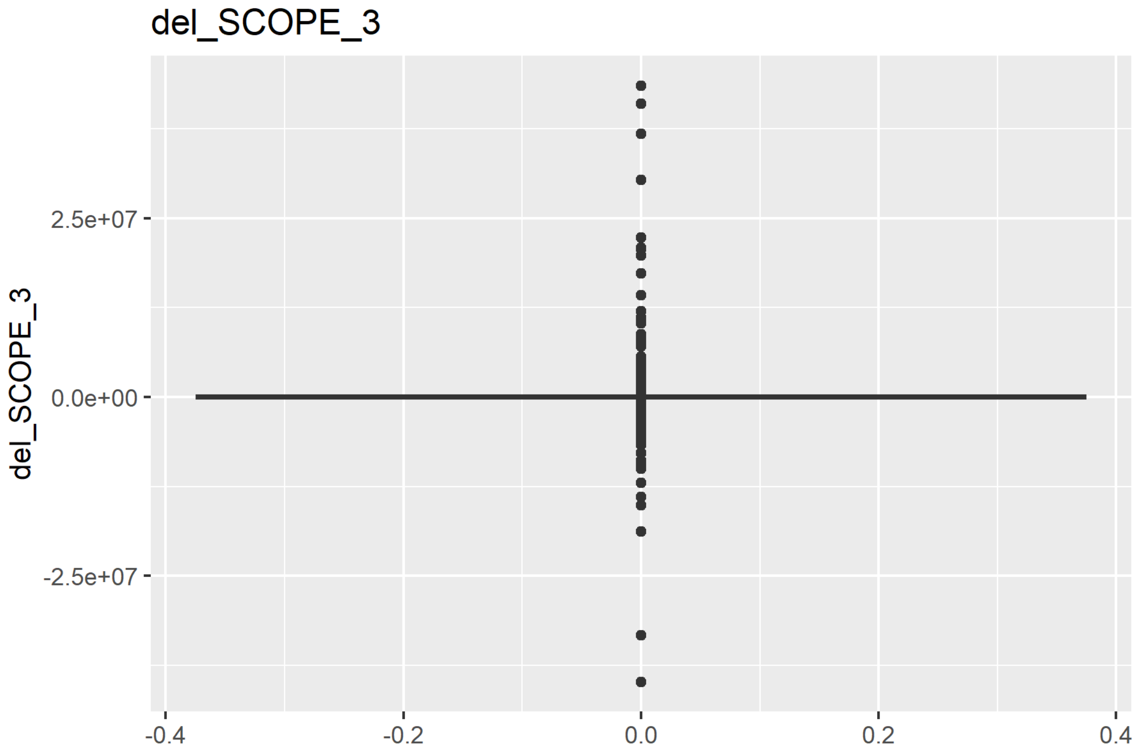
-0.4
-0.2
0.0
0.2
0.4

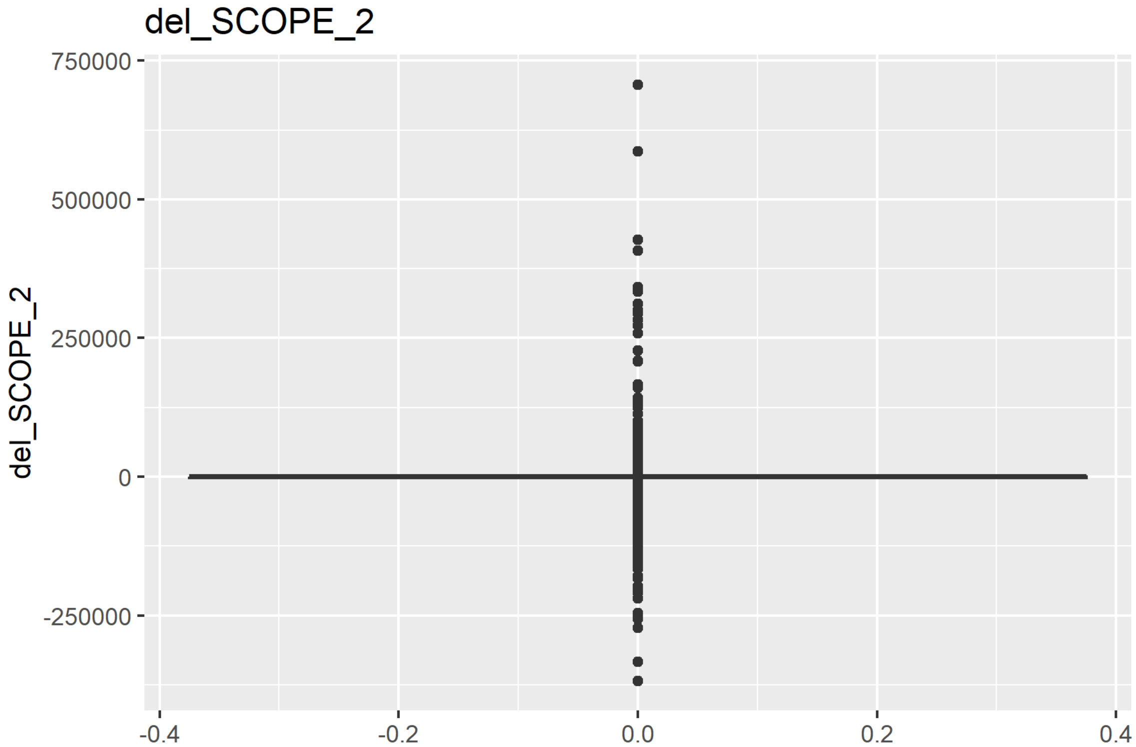

LAG_LOGSCOPE_3
LAG_LOGSCOPE_3
15
10
5
0
-0.4
-0.2
0.0
0.2
0.4

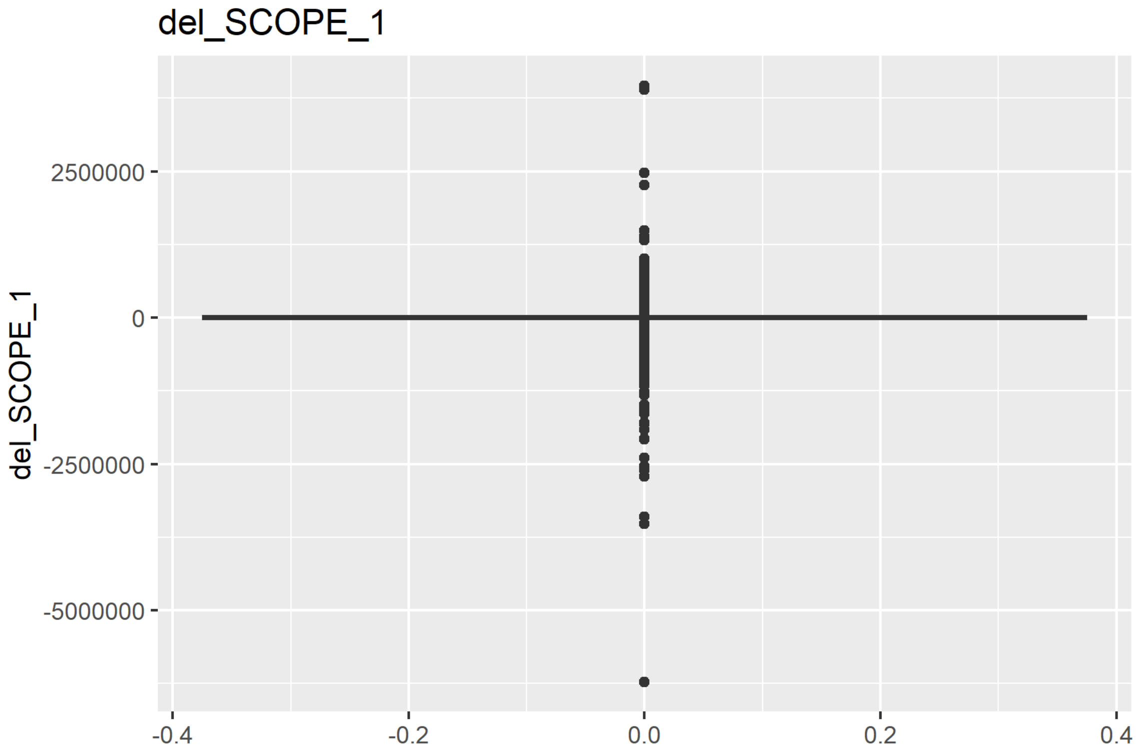

LAG_LOGSCOPE_2
LAG_LOGSCOPE_2
15
10
5
0
-0.4
-0.2
0.0
0.2
0.4

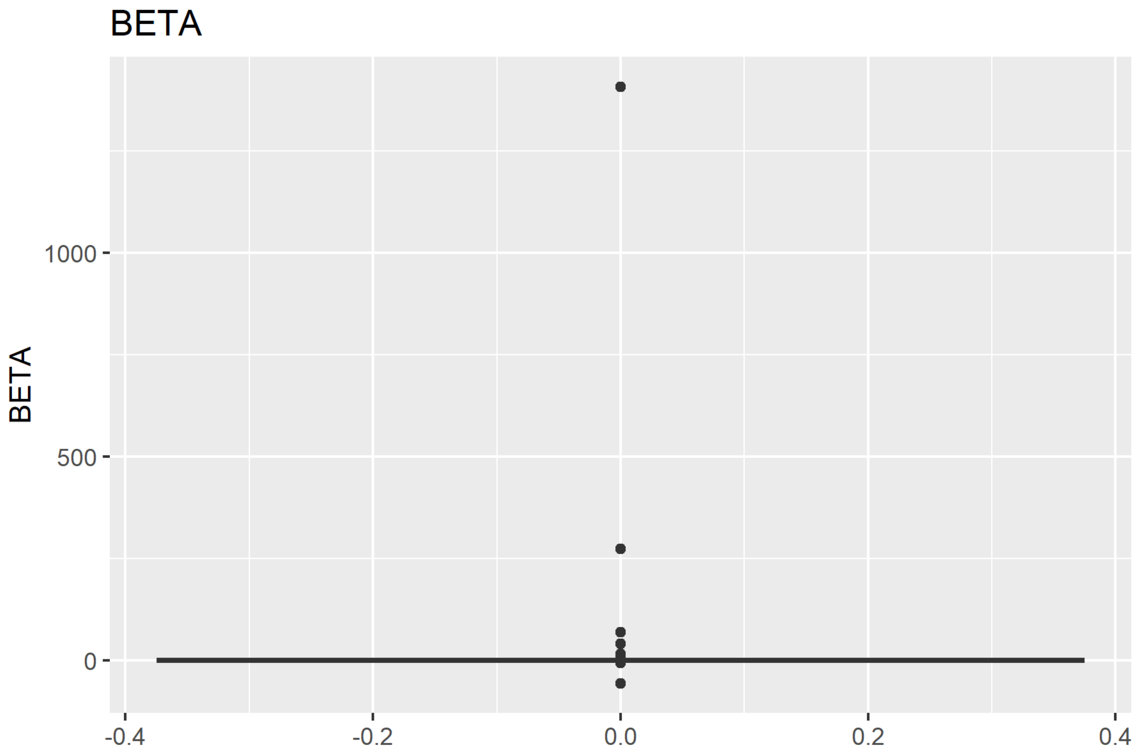

LAG_LOGSCOPE_1
LAG_LOGSCOPE_1
15
10
5
0
-0.4
-0.2
0.0
0.2
0.4

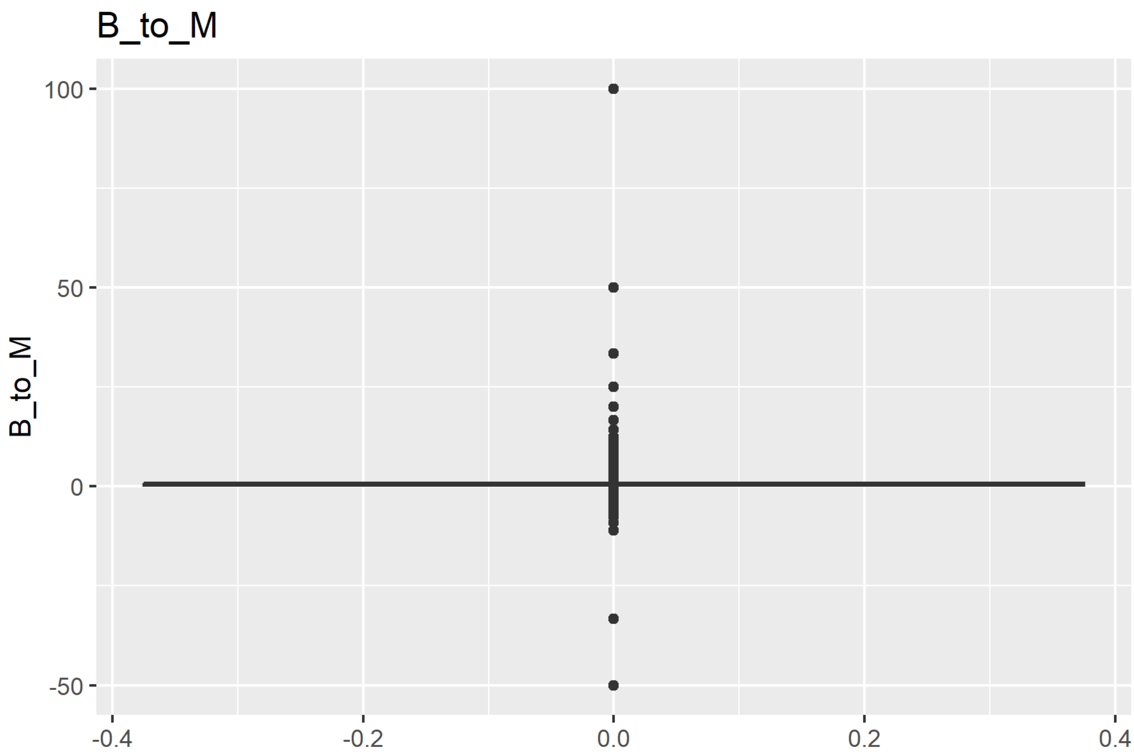

EPSGR
10
5
0
-5
-10
EPSGR
-0.4
-0.2
0.0
0.2
0.4


del_SCOPE_3
2.5e+07
0.0e+00
-2.5e+07
del_SCOPE_3
-0.4
-0.2
0.0
0.2
0.4


del_SCOPE_2
750000
500000
250000
0
-250000
del_SCOPE_2
-0.4
-0.2
0.0
0.2
0.4

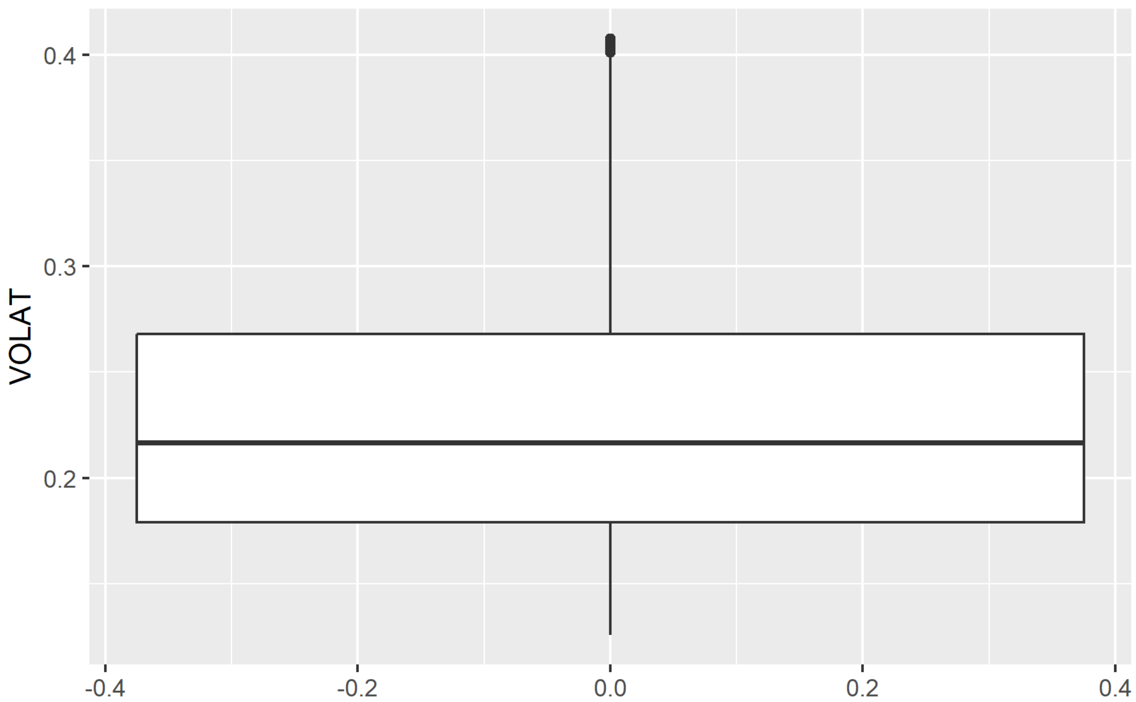

del_SCOPE_1
2500000
0
-2500000
-5000000
del_SCOPE_1
-0.4
-0.2
0.0
0.2
0.4



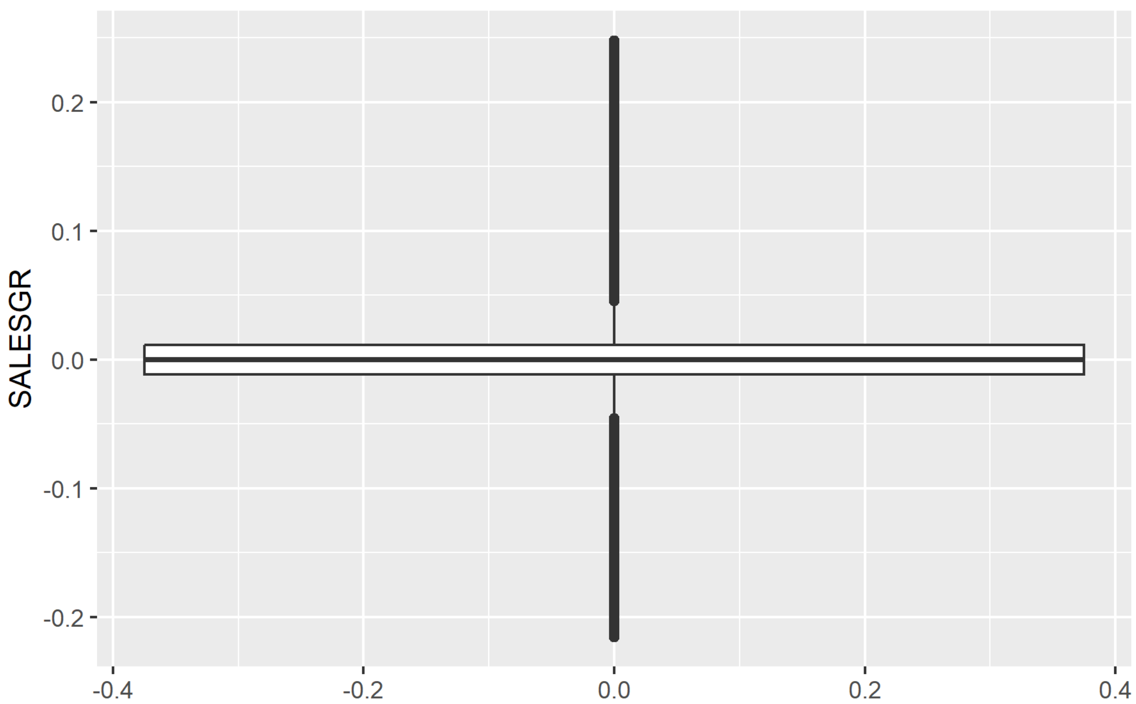


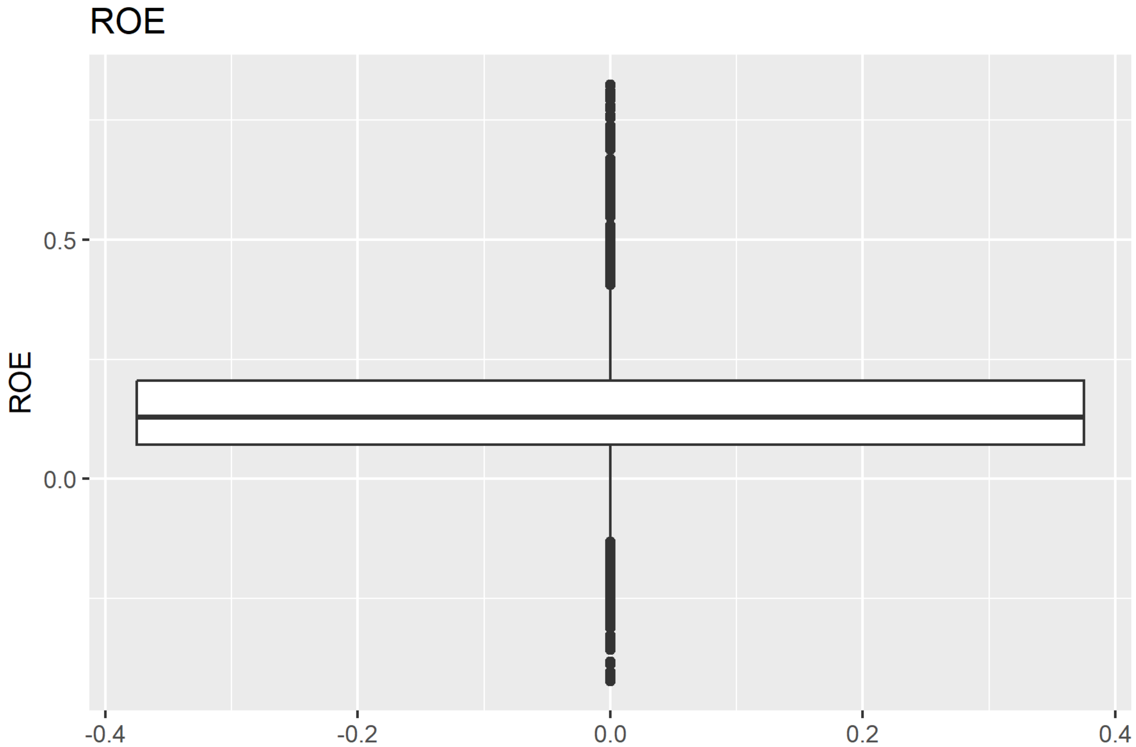
Appendix 3: Box plots of variables after winsorizing

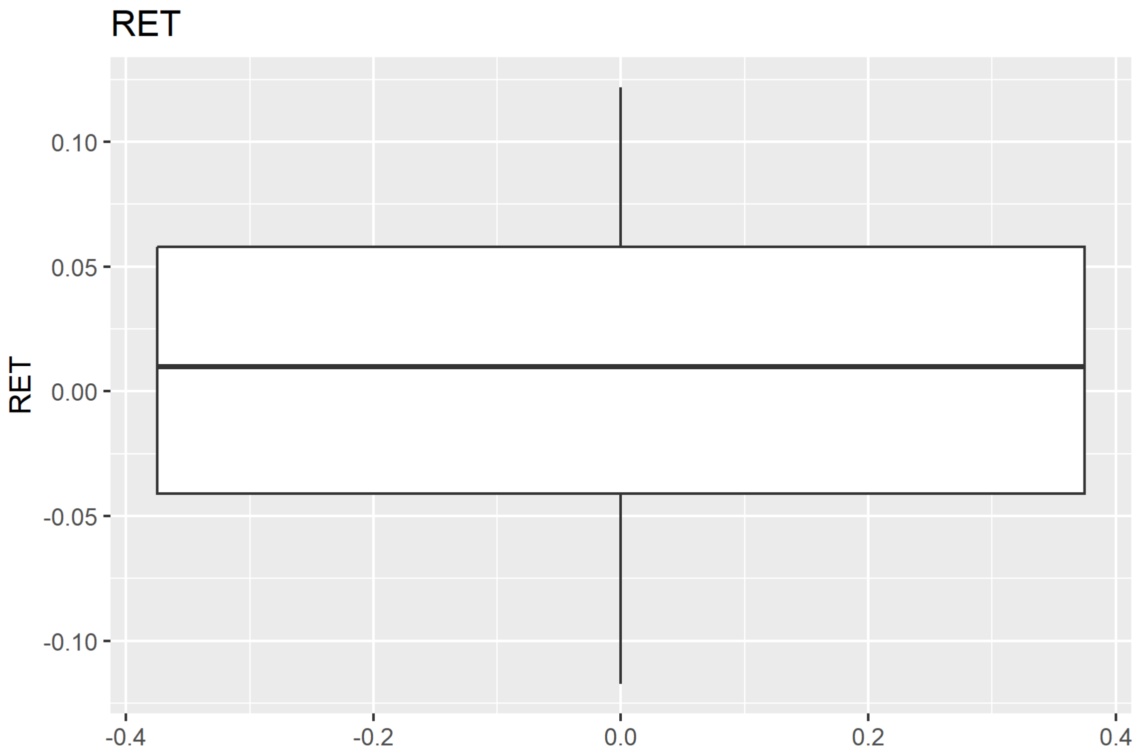
VOLAT

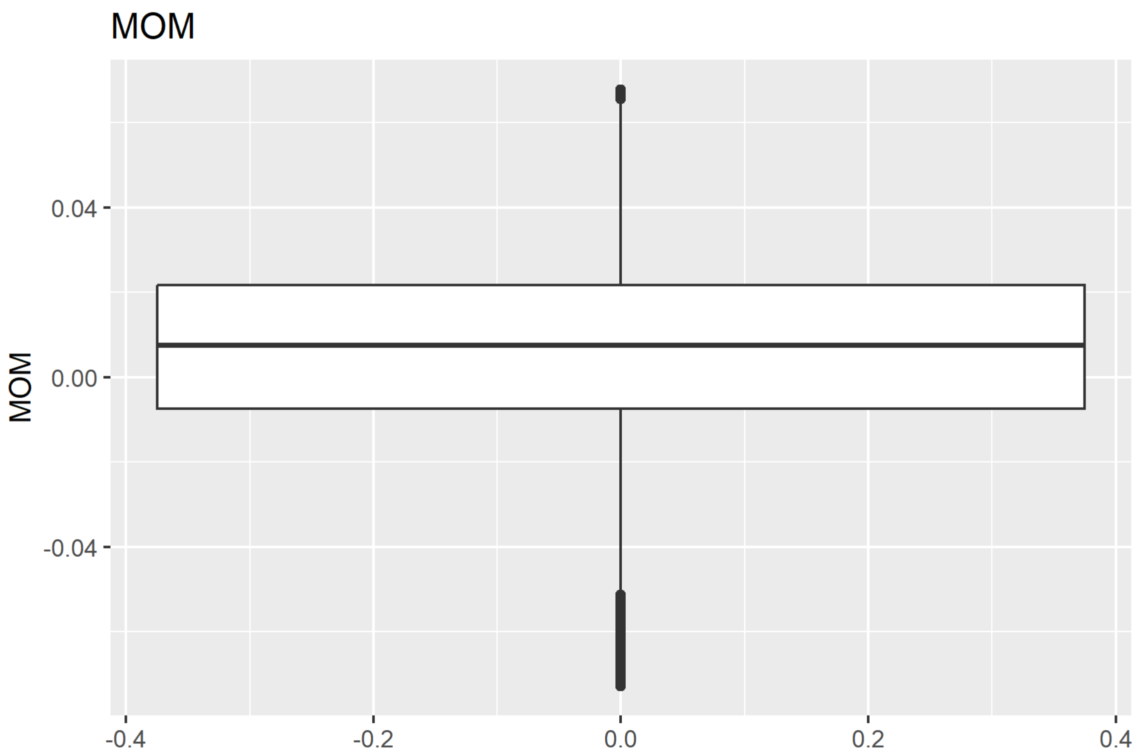


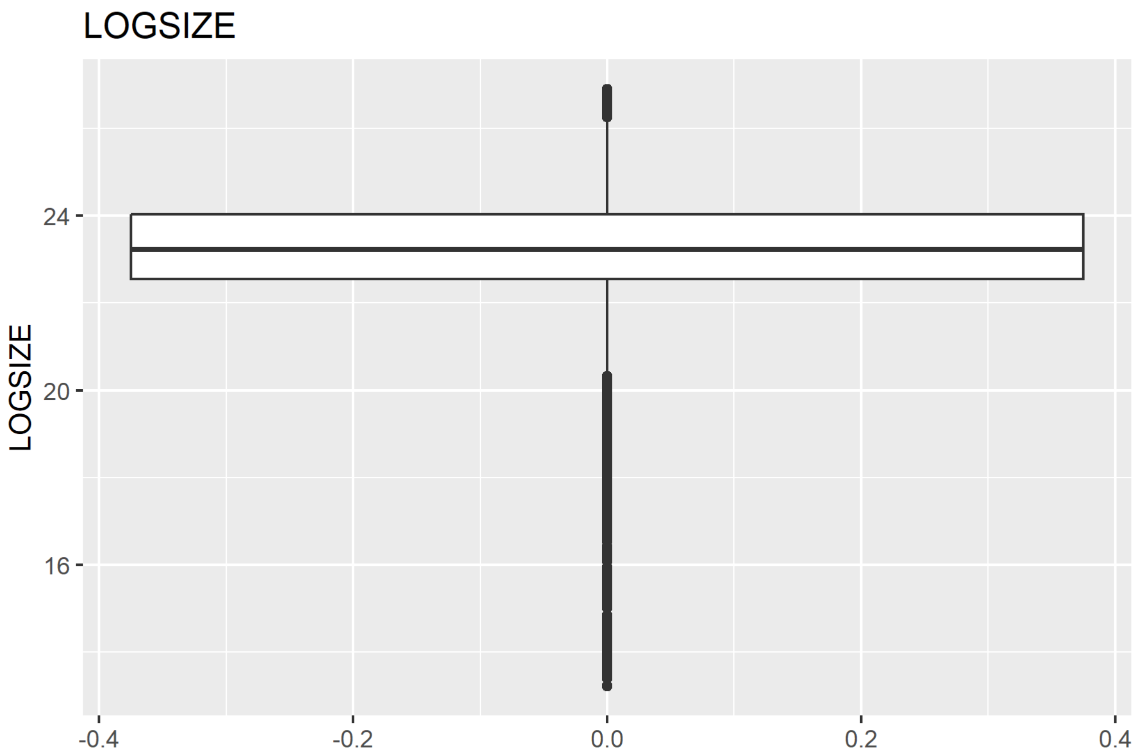
SALESGR

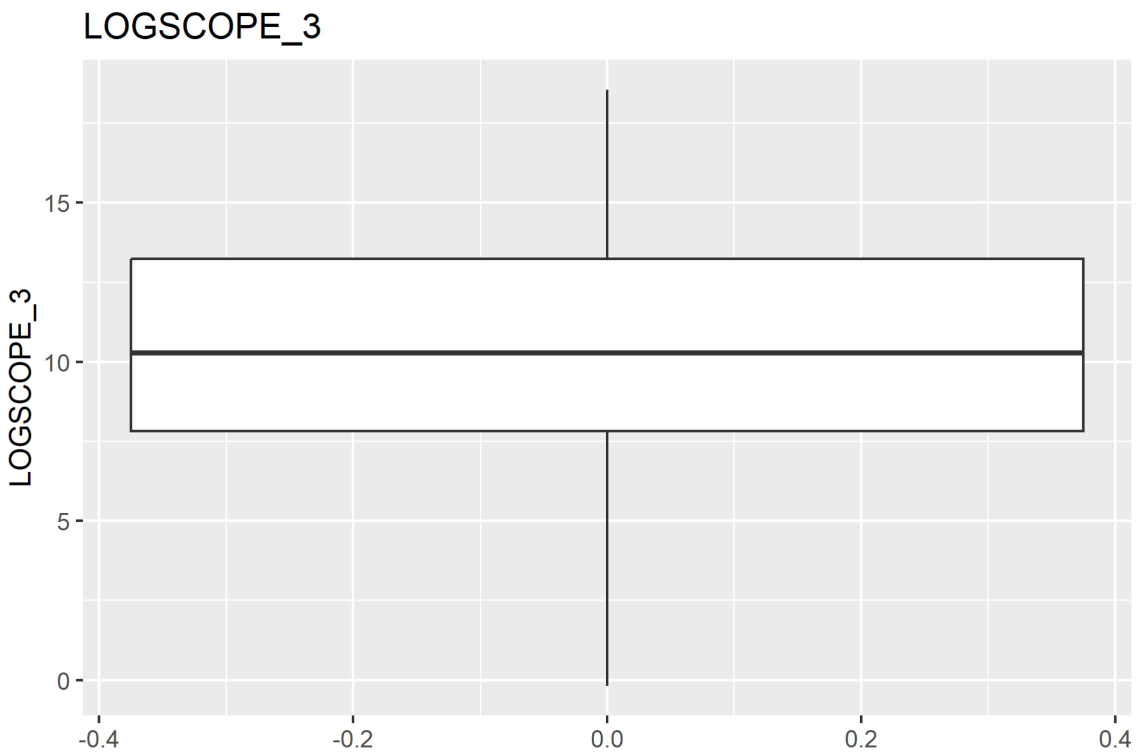


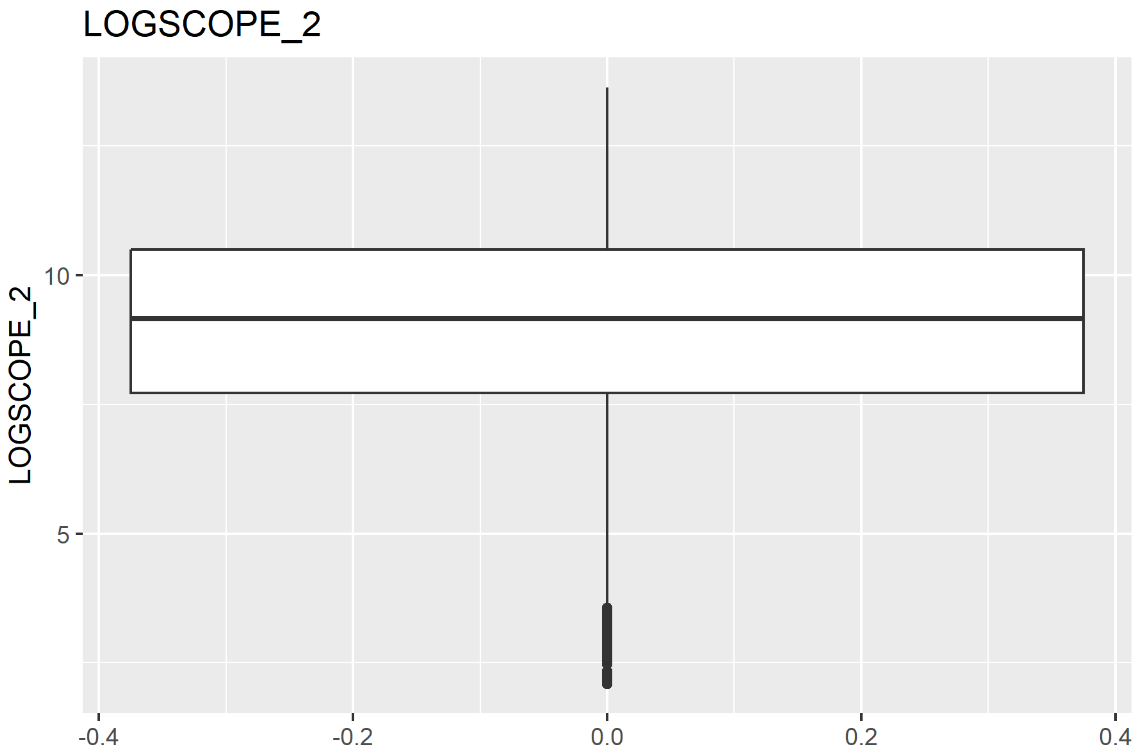

ROE
0.5
0.0
-0.4
-0.2
0.0
0.2
0.4

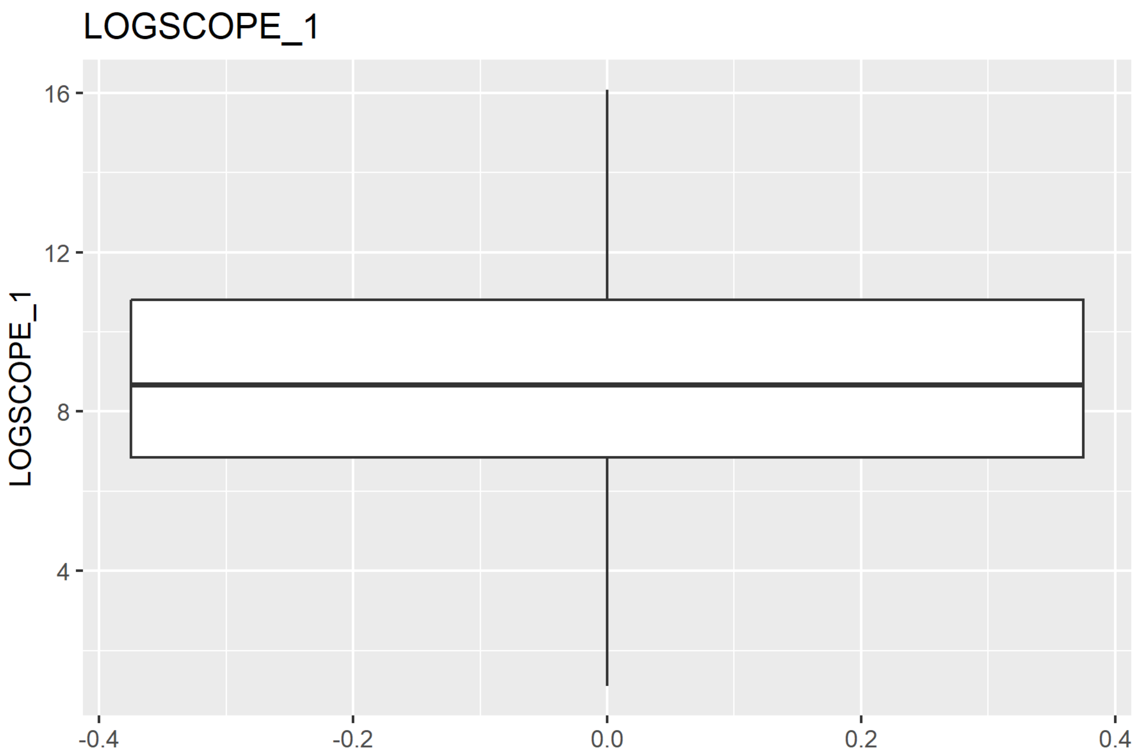

RET
0.10
0.05
0.00
-0.05
-0.10
-0.4
-0.2
0.0
0.2
0.4

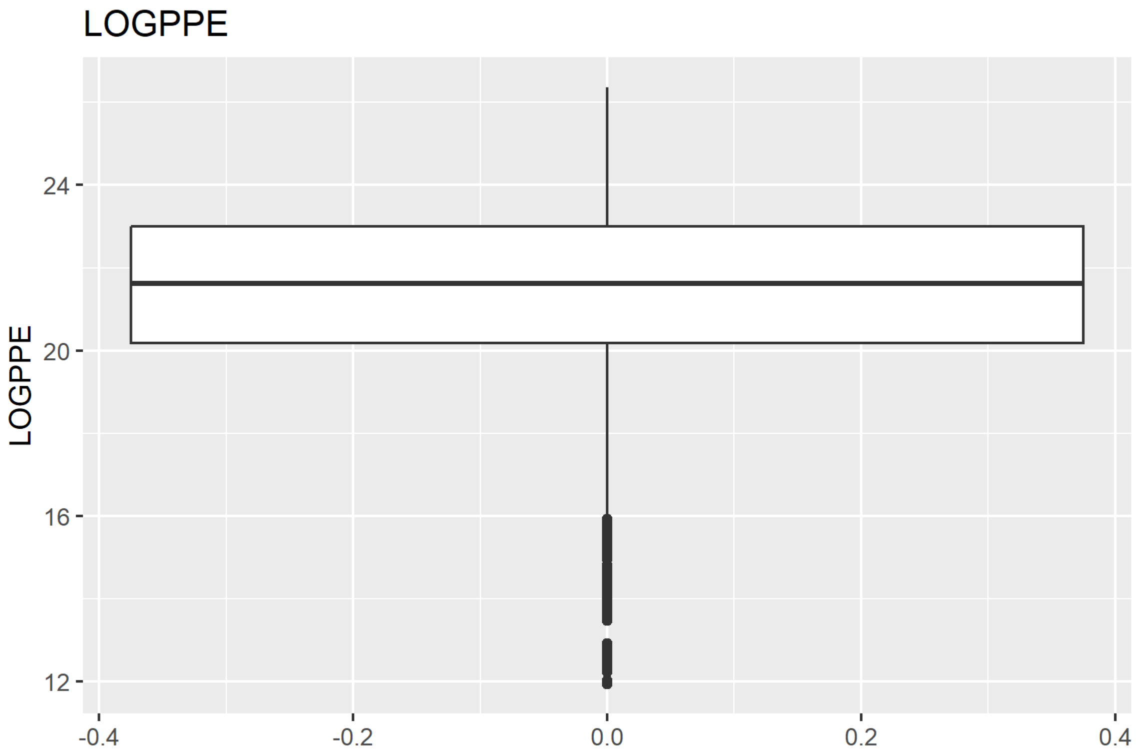

MOM
MOM
0.04
0.00
-0.04
-0.4
-0.2
0.0
0.2
0.4

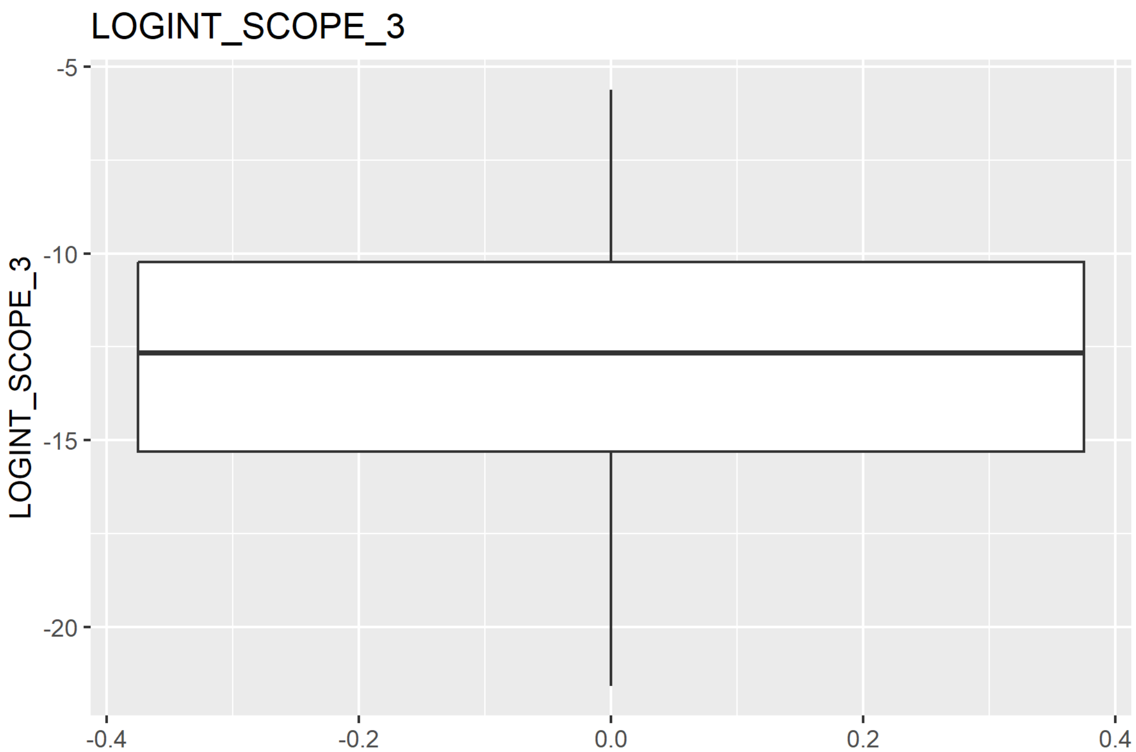

LOGSIZE
LOGSIZE
24
20
16
-0.4
-0.2
0.0
0.2
0.4

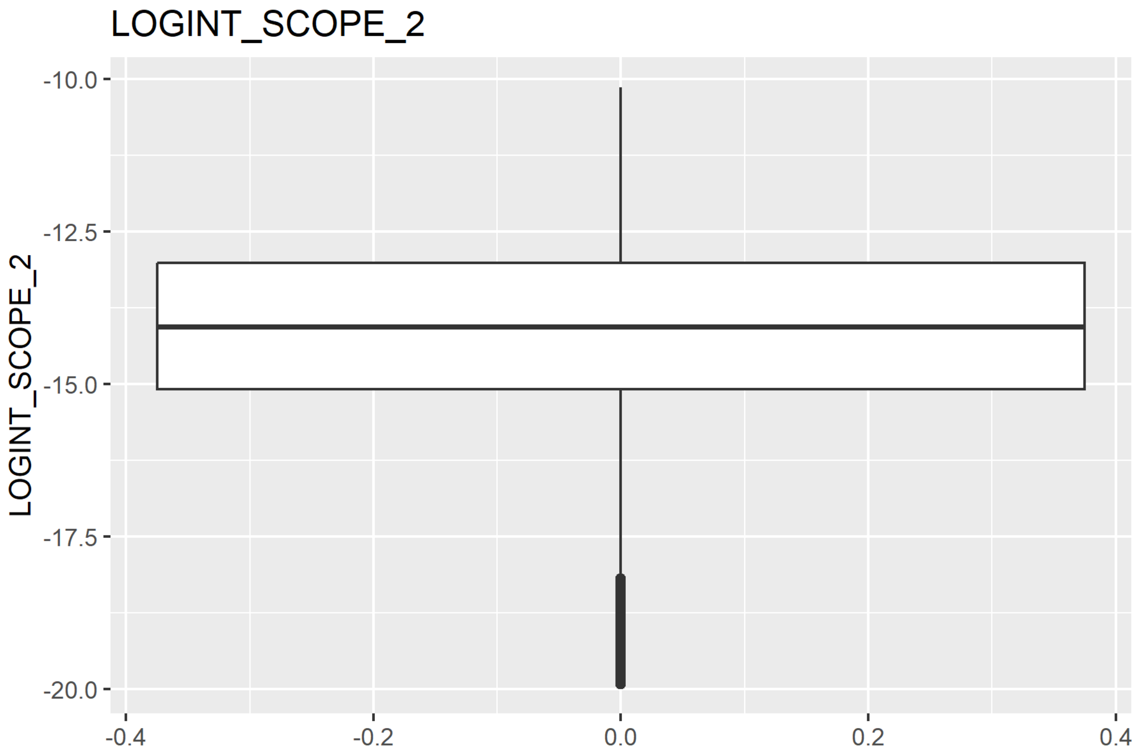

LOGSCOPE_3
LOGSCOPE_3
15
10
5
0
-0.4
-0.2
0.0
0.2
0.4

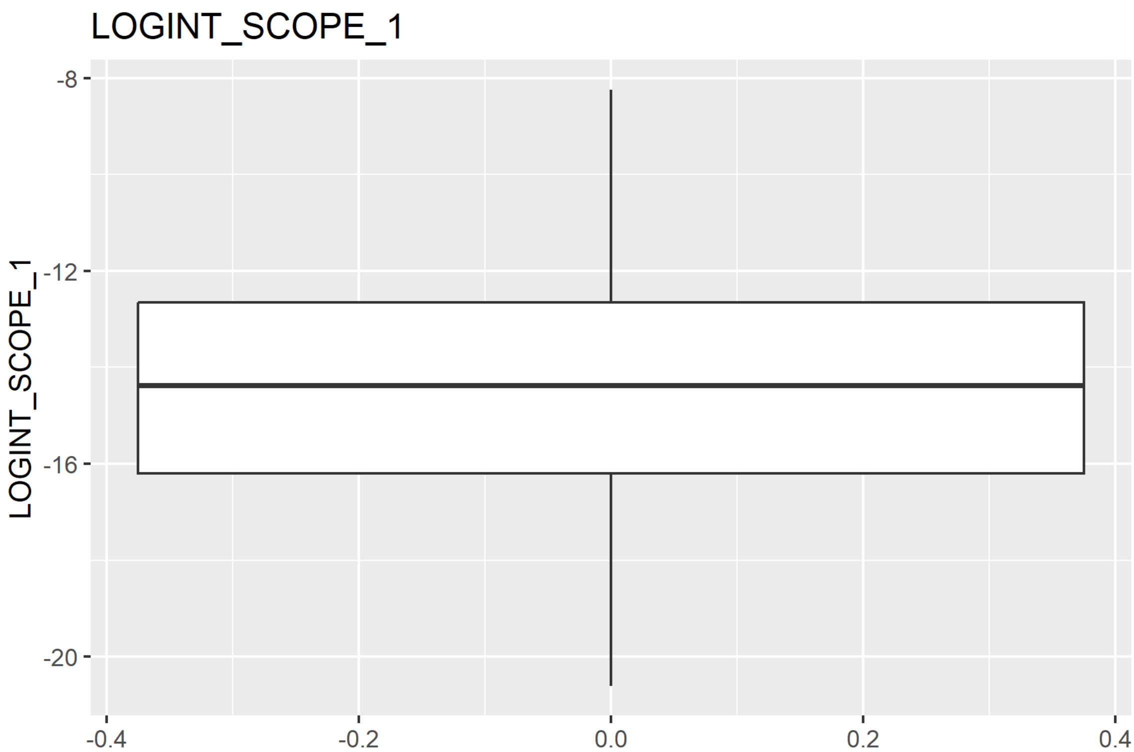

LOGSCOPE_2
LOGSCOPE_2
10
5
-0.4
-0.2
0.0
0.2
0.4

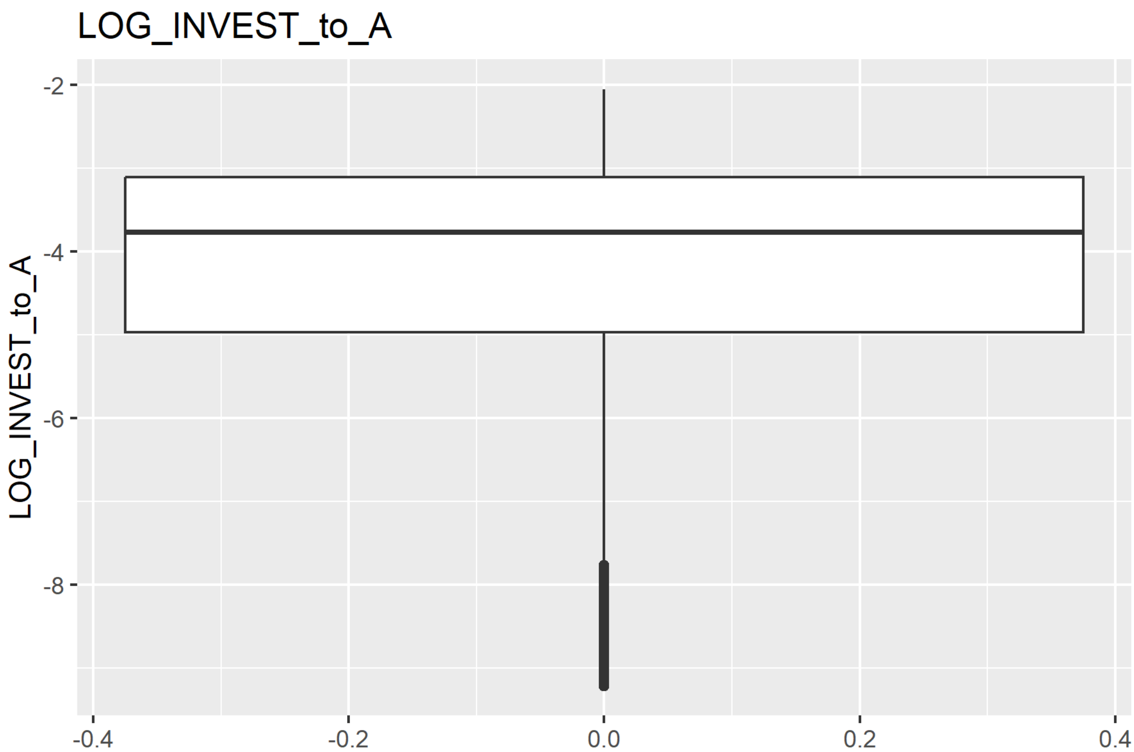

LOGSCOPE_1
16
12
8
4
LOGSCOPE_1
-0.4
-0.2
0.0
0.2
0.4


LOGPPE
24
20
16
12
LOGPPE
-0.4
-0.2
0.0
0.2
0.4

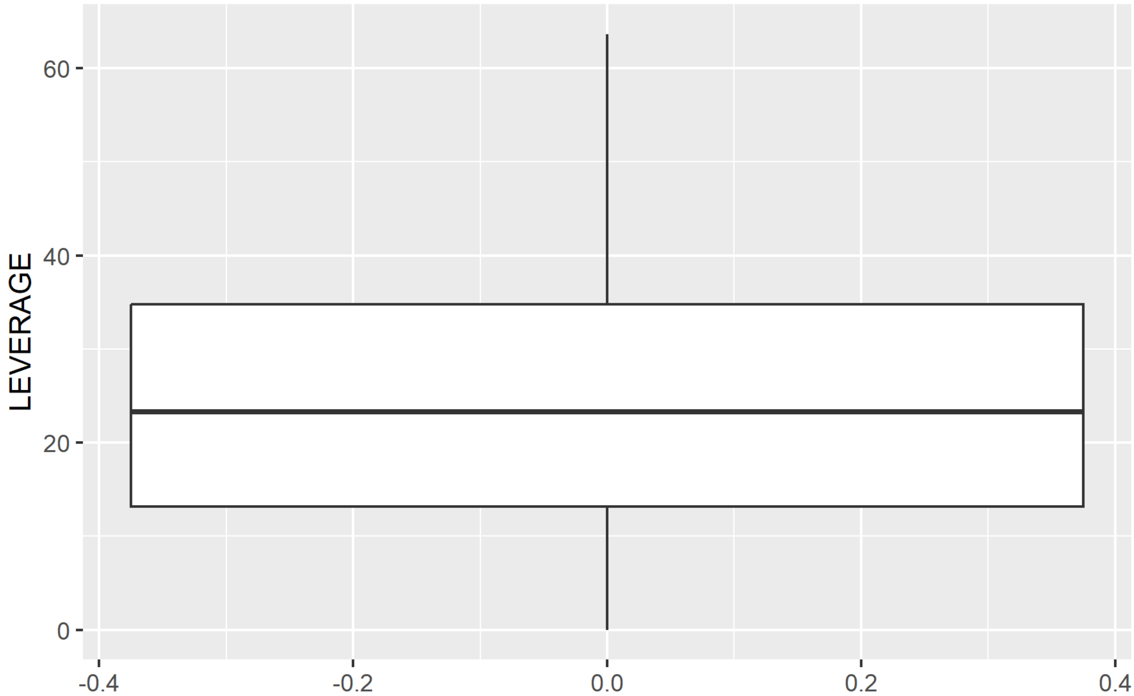

LOGINT_SCOPE_3
-5
-10
-15
-20
LOGINT_SCOPE_3
-0.4
-0.2
0.0
0.2
0.4


LOGINT_SCOPE_2
-10.0
-12.5
-15.0
-17.5
-20.0
LOGINT_SCOPE_2
-0.4
-0.2
0.0
0.2
0.4

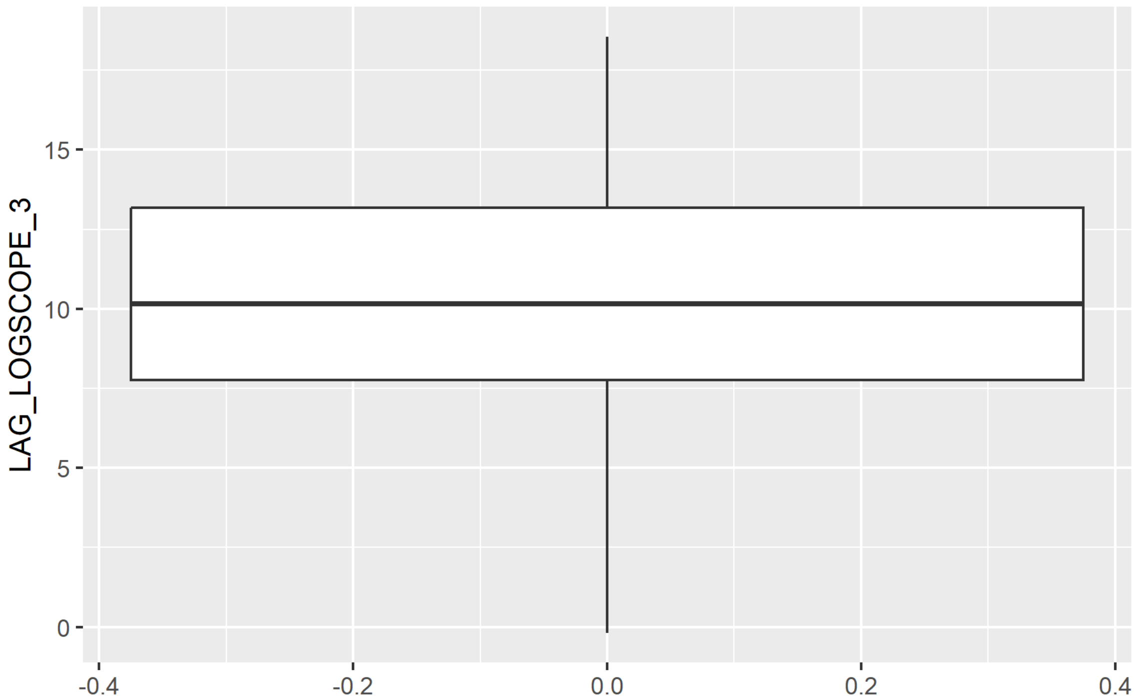

LOGINT_SCOPE_1
LOGINT_SCOPE_1
-8
-12
-16
-20
-0.4
-0.2
0.0
0.2
0.4


LOG_INVEST_to_A
LOG_INVEST_to_A
-2
-4
-6
-8
-0.4
-0.2
0.0
0.2
0.4

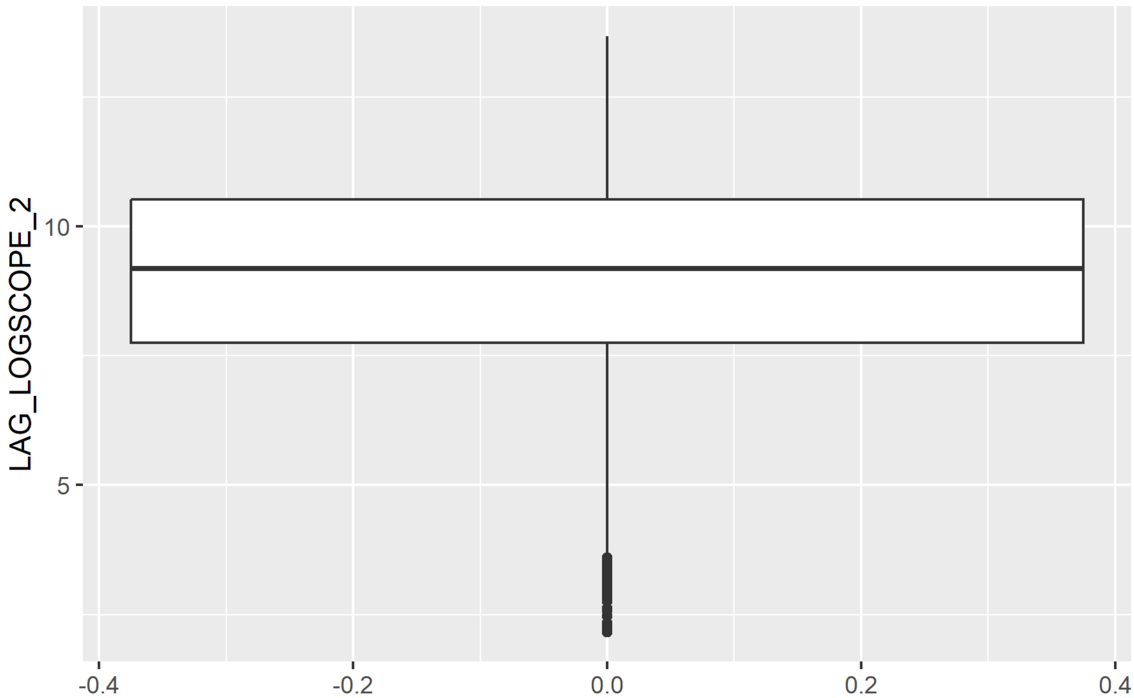
LEVERAGE



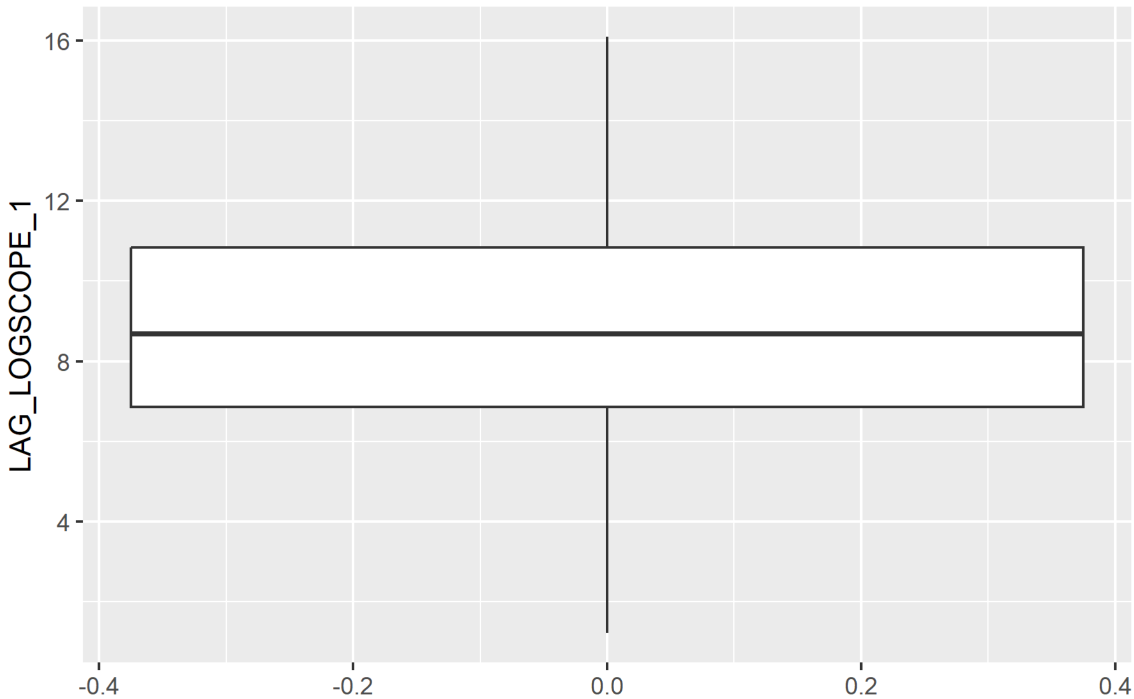
LAG_LOGSCOPE_3

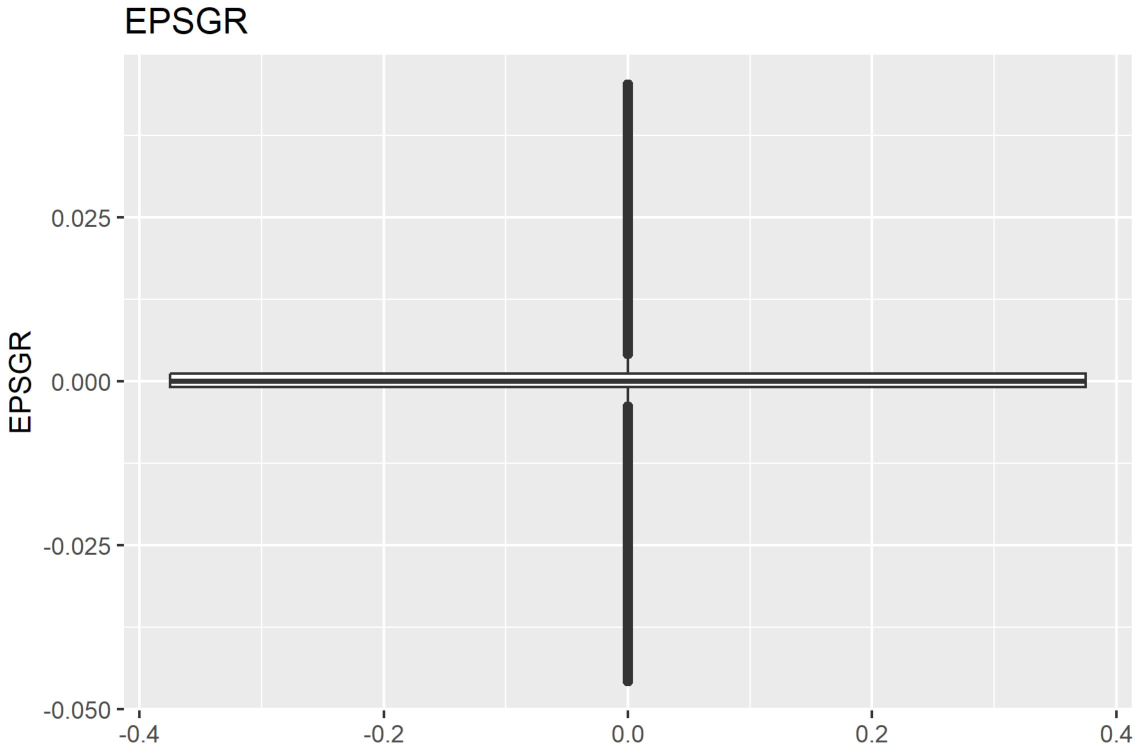


LAG_LOGSCOPE_2



LAG_LOGSCOPE_1




EPSGR
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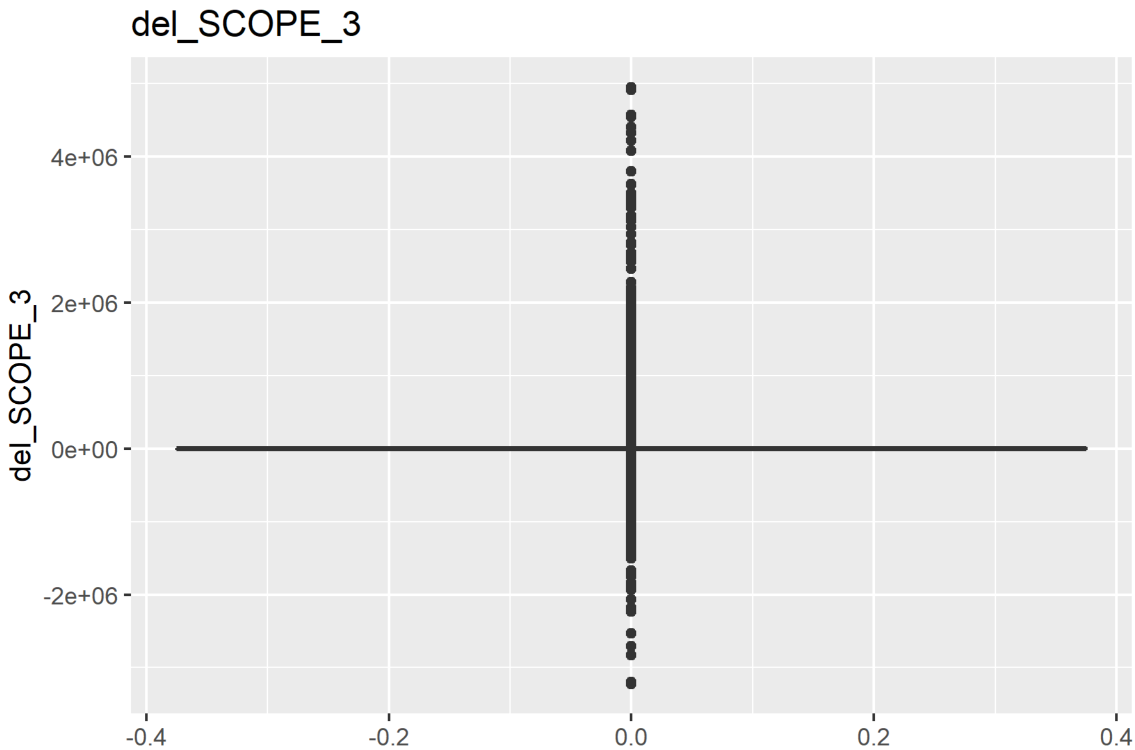
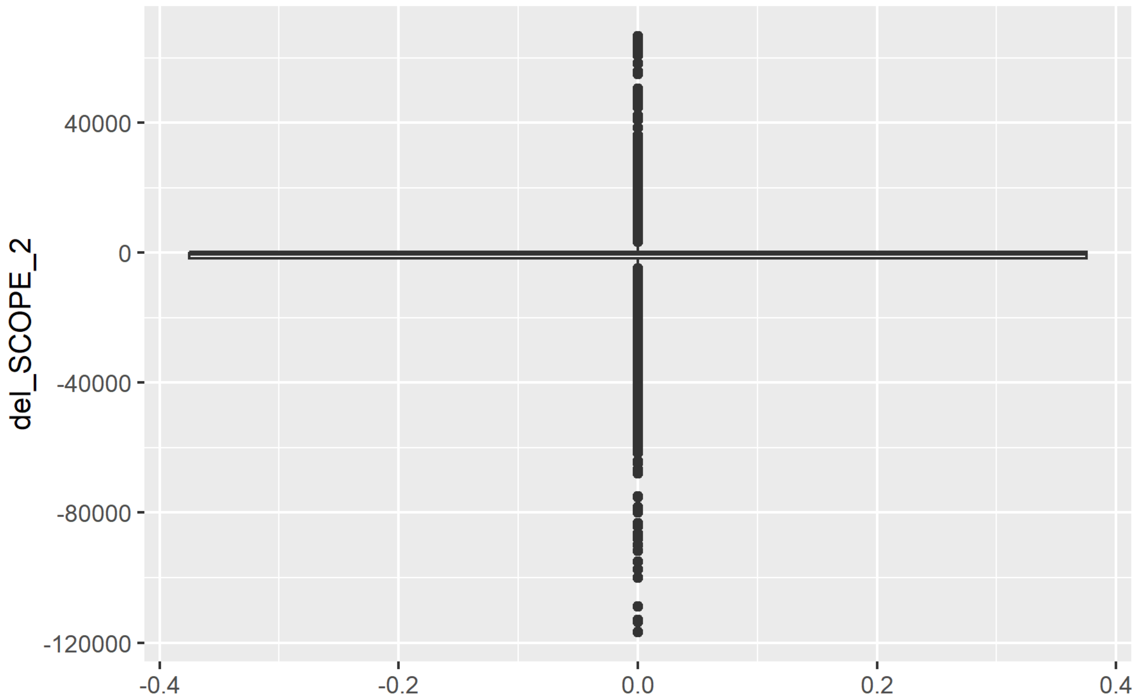
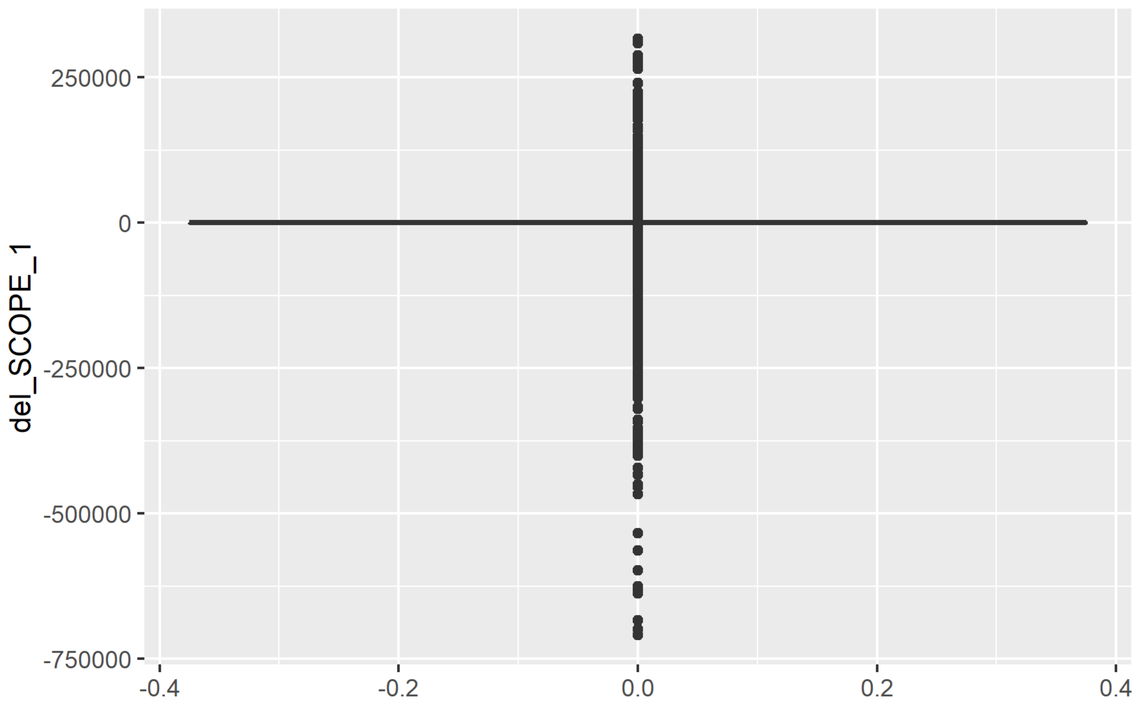
0.000
-0.025
-0.050
EPSGR
-0.4
-0.2
0.0
0.2
0.4

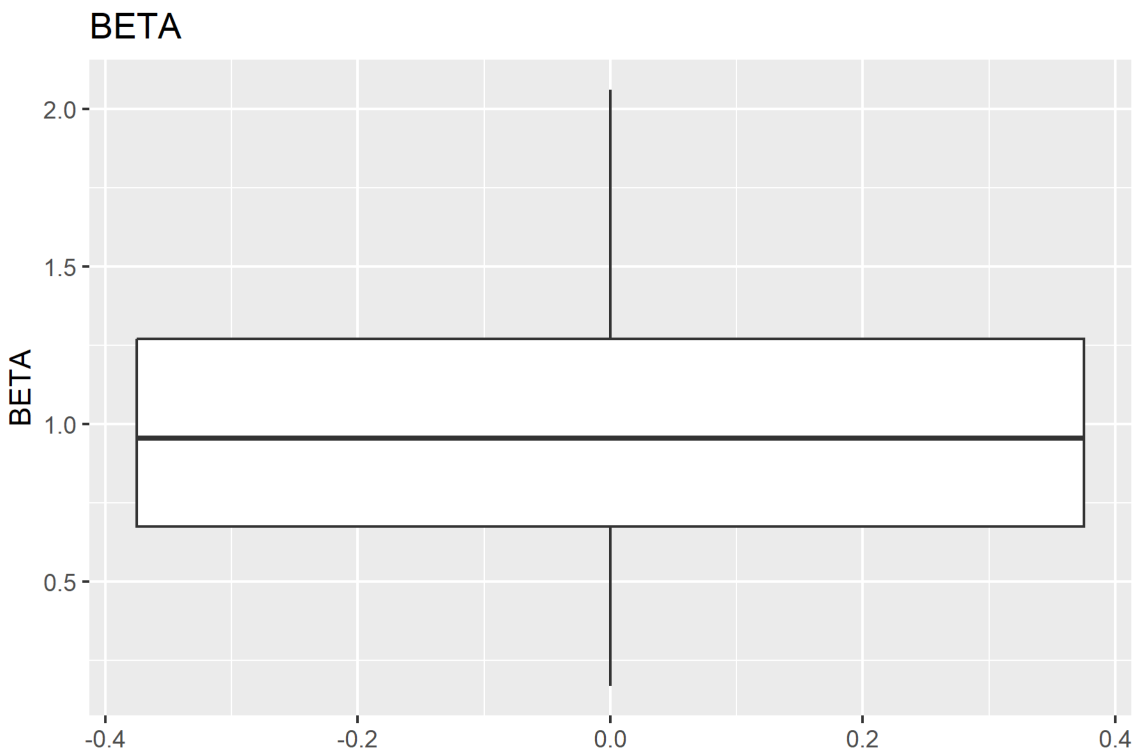

del_SCOPE_3
4e+06
2e+06
0e+00
-2e+06
del_SCOPE_3
-0.4
-0.2
0.0
0.2
0.4

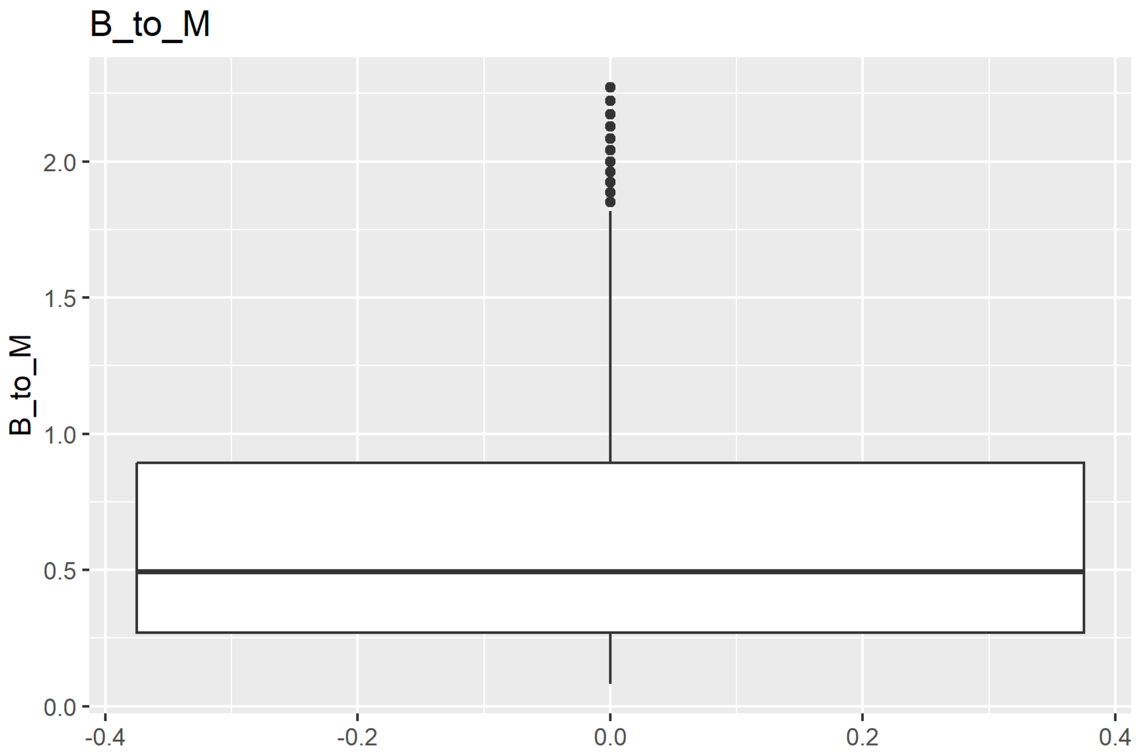
del_SCOPE_2



del_SCOPE_1




BETA
2.0
1.5
1.0
0.5
BETA
-0.4
-0.2
0.0
0.2
0.4


B_to_M
2.0
1.5
1.0
0.5
0.0
B_to_M
-0.4
-0.2
0.0
0.2
0.4