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Socially Responsible Investment

A Case Study Of A Negatively Screened S&P 500 Fund From 1990-2018

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ABSTRACT

In daily life, humans tend to not exhibit pure selfishness. Some level of altruism is in most individuals' self-interest. Does the same hold true for investment? This paper argues that it is in an individual's interest to invest in a cause he supports. I examine socially responsible investing and its impact on fund performance. I then construct my own socially responsible fund by negatively screening components (yielding a separate, 'unethical' fund) from Standard and Poor's S&P500 Index. I examine the ethical and unethical funds' performance on a semi-annual basis from 1990-2018 and compare each portfolio's total return and risk-adjusted return to the underlying index and sets of random portfolios. I conclude that ethical funds do not outperform either traditional or 'unethical' funds.

Table of Contents

INTRODUCTION

Humans act in their self-interest, but they are not selfish. We observe varying levels of altruism in our everyday life; holding the door for a stranger, helping an old lady across the street, giving food to a panhandler. These activities all come at personal cost to individuals, yet they still take place. People act in this way because the personal benefit that their actions bring outweigh their personal cost; furthermore, there is social benefit gained through their actions. These positive externalities are the premise by which socially responsible investment shapes myriad industry.

This paper compares the return of a socially responsible investment (SRI) portfolio, its underlying index, and a 'sin' portfolio. I assert that the socially responsible portfolio will outperform the other two portfolios. A cause can be anything: gun control, environmental protection, Christian values, Muslim values, Jewish values, pro-choice, pro-life, pro-cat, pro-dog, etc. Causes frequently have a normative judgment associated with them. Abortion is 'wrong,' or guns are 'evil.' Gun control is 'right' or pro-life is 'good.' We can oppose wrong or evil causes by 'negatively screening' them from our lives. With a negative screen we remove or subtract the opposed cause from our lives; we might avoid going to an abortion clinic or never purchase a gun. The other option would be 'positive screening.' We can add or include a cause by actively protesting outside of an abortion clinic or advocating for gun control legislation. In applying these screens we hope to make the world a better place for current and future generations.

Just like how we screen causes in our personal lives so too can we screen for causes in investments. Most people invest in the financial profit cause; however, doing so puts them in a perverse equilibrium where they are funding the very causes they actively fight. Cause-based investing is the solution to this problem. With cause-based investing, people are incentivized to invest in companies whose causes they support while shunning causes they disapprove of.

This paper conducts a case study of the S&P 500 Index (the ‘underlying index’) from 1990 – 2018. I construct a socially responsible fund (SRF) by analyzing the historical constituents of the S&P 500 on a semi-annual basis. From these constituents I negatively screen companies based on their Global Industry Classification Standard (GICS) code. The negative screen has a ‘left-leaning’ association or cause to it; I am screening out coal & consumable fuels (10102050), aerospace & defense (20101010), tobacco (30203010), casinos (25301010), and alcohol (30201010 and 30201020)).

Once the underlying index has been screened, I compare my SRF, the underlying index, and the removed ‘sin’ portfolio. I compare total return and risk-adjusted return, using the Sharpe Ratio and Jensen’s Alpha. Sharpe’s Ratio allows for ordinal ranking of the funds while Jensen’s Alpha is used to determine how much additional performance is gained (lost) as a result of the investment strategy. A higher Sharpe Ratio indicates a higher risk-adjusted return; portfolios are may be ranked ordinally using this concept. I find that the unethical portfolio outperforms both the ethical portfolio and the SP500 on an absolute basis but has an inferior return on a risk-adjusted basis. No strategy has statistically significant excess performance.

To assess the robustness of the primary results of this paper, portfolios consisting of random subsets of the S&P500 are constructed, and their performance is measured. These subsets are used to demonstrate that the ‘unethical’ strategy is, in fact, generating excess absolute return or lower-risk adjusted return due to non-chance factors. As a final check, outliers are removed from each of the sin and random portfolios and their performance is then recalculated.

This further demonstrates that the fundamental underlying investment strategy is the cause of any excess return, as opposed to luck.

The rest of the paper is broken down as follows: the history section explores SRI from biblical times to modern day. The literature review explores common academic approaches to SRI analysis and how they are relevant to this study. Data and methodology describe the data used in this paper, as well as the explicit steps to manipulate the data and create the portfolio returns. Results & analysis discusses the paper's primary findings and implications; conclusion is eponymous.

HISTORY

Socially responsible investment (SRI) has primarily religious origins. The Bible, Torah, and Quran all impose restrictions on the activities of individuals. These restrictions can be both dietary and financial; both types of restrictions have economic implications. The Torah (and the Old Testament) outlines financial restrictions on loans in Ezekiel 18:13 and 18:17:

> "….he that hath not given forth upon interest, neither hath taken any increase, that hath withdrawn his hand from iniquity, hath executed true justice between man and man…that hath withdrawn his hand from the poor, that hath not received interest nor increase, hath executed Mine ordinances, hath walked in My statutes; he shall not die for the iniquity of his father, he shall surely live…" (Ezekiel 18:8, 18:17).

The Torah proscribes loans with (excessive) interest. It is in line with Jewish law to give out fair loans; unfair loans are implied to beget a death penalty. Further restricted loan activity is listed in Exodus 22:25 – 22:27. Leviticus 25:36 – 25:55 also deals with loan restrictions and prohibits slavery. There are even rules for land use -- Exodus 23:10 - 23:11 outline six years of farming with a mandatory seventh year of rest for the land. How are these rules socially responsible? The interest rules are an attempt to prevent a 'poverty trap' for some very poor individuals in Jewish society. A high interest rate for an indigent borrower may make the borrower incapable of ever repaying his loan and he will therefore remain in poverty indefinitely. The land restriction is a common farming technique (though not necessarily in a six years on, one year off format) to not wear down arable land. This technique sacrifices short term profit of the farmer, since he 'loses' some of his crop yield 14% of the time. It is a socially responsible rule in the sense that long term profits of both the farmer and society are increased; i.e. the land is not depleted as quickly and continues to produce crops for a much longer time period. Note also a sense of 'responsibility' or 'respect' for the Earth in this example; this is the very premise of 'eco-friendly' movements today.

Kashrut, or the Jewish dietary laws, place restrictions on which animals the Jewish people may eat. Kashrut compliant food is colloquially referred to as kosher. Leviticus 11 and Deuteronomy 14 outline most of the dietary restrictions. Any animal that is "…wholly cloven-footed, and cheweth the cud…" may be eaten (Leviticus 11:3). Sheep, goats and cows are kosher while pigs and rabbits are not. The link to social responsibility by imposing restrictions on a community's diet is slightly more complicated. Economic harm is easy to see; farmers/shepherds cannot raise certain animals and society has less food as a whole. The gains are primarily in the form of fewer sick individuals. Much of the foods proscribed are scavengers and animals with an unknown cause of death. In light of this, the rules are clearly intended to prevent people from getting sick by consuming tainted meat. An animal with an unknown cause of death is most likely diseased. Scavengers may have posed a higher risk (greater chance of carrying harmful bacteria) than non-scavengers. In this way any losses from a restricted food supply are presumably negated by gains in well-being and health. Sick worshipers are, after all, not very productive worshipers.

The Quran also imposes financial and dietary restrictions upon Muslim worshipers. The Quran 2:173,4:43, and 5:3 explain the dietary restrictions for Muslims. Quran compliant foods are called halal (lawful). The Quran imposes financial restrictions in Quran 2:275, 3:130, 4:161, and 30:39. These restrictions are designed to prevent what is called riba (usury); these verses provide the basis for modern day Shariah complaint investing, i.e. they outline what is halal and what is haram (unlawful). Muslim individuals do not invest in companies that charge compound interest, as they consider it to be riba. Furthermore, they do not invest in companies that produce alcohol or pork, and they do not invest in gambling (casinos). The foregoing proscriptions are likely intended to increase worker productivity. Drunks cannot work as hard as sober individuals; pork is hard to cook thoroughly and is a common carrier of trichinella, a bacterium that can cause diarrhea and vomiting. Furthermore, this bacterium can be passed along from pigs to other livestock; therefore, harming the pig industry produces a positive externality for the other livestock industries, i.e. fewer sick animals. Interest provisions are again intended to prevent a ‘poverty trap.’ I assume that Mosques prefer revenues come to them rather than casinos; those prohibitions may also be designed to protect women and children from husbands who are serial gamblers.

Fast forward a millennium to the mid-1700s. The Reverend John Wesley, an English Methodist, gave a sermon titled “The Use of Money.” Based on Luke 16:9, Wesley outlines how to operate in the economy in an ethical manner. He prohibits poaching, pawning goods, charging excessive interest and even selling below market price to put others out of business (Wesley, Section 1 Paragraph 3). He also prohibits the consumption of ‘liquid fire,’ or alcohol (Section 1 Paragraph 1). Wesley is yet another example of religion at the forefront of socially responsible investment. His sermon encourages worshippers to use their funds in an ethical manner by avoiding certain industries and practices, such as alcohol and high interest loans.

Around the same time period in America, the Quakers (Society of Friends) began to publicly denounce slavery; Quakers were prohibited from investing in the slave trade. The Quakers would actively lobby and petition local governments to prohibit slavery; this grassroots movement would influence the abolition movement in America for centuries to come, persisting through the Civil Rights movement in the 1960s and possibly to present-day America through anti-discrimination laws and reforms. The Quakers highlight how a community can use its financial and political power to support a socially responsible cause.

Modern day SRI began around the mid-20th century. Three of its major contributions during that time period, from the mid-1900's to present, was the creation of the Valdez Principles (1990), mass divestment from South Africa as a result of the South African National Party's Apartheid policy (1960-1988) and providing financial support to facets of the Civil Rights movement (1954-1968). Beginning in 1960s, churches and businesses began to invest in minority groups and divest from or protest against businesses that were perceived as unethical. The 1967 Dow Chemical protests over the use of napalm in Vietnam is the first example of investors excluding arms manufacturers from their portfolios. Also in 1967, the Ford Foundation announced "higher-risk, lower-return investments in minority businesses, housing, and conservation projects" (Bruyn 1987, p.1). In 1968, the General Assembly of the Presbyterian Church established the Presbyterian Economic Development Corporation. Their goal was to invest in minority housing, minority businesses, and banks that had a strong record of providing loans to minorities (Bruyn 1987, p.2). In 1977, General Motors, through pressure by board member Reverend Leon Sullivan, divested its holdings in South Africa. Groups that failed to divest their South African assets, such as Dutch Royal Shell and Coca-Cola, were met with consumer boycotts (Judd 1990, p. 42). In 1988, the United States passed a tax code change that prevented businesses from deducting their operating expenses in South Africa. The South African National Party ended their Apartheid policy in 1994; whether or not this decision was the direct result of socially responsible investment is unclear. However, the constant financial pressure the South African government faced surely didn't assist their situation. These tiny victories, propagating into wide-scale success, are the basis for an individual to undertake socially responsible investment; who can say with certainty widespread economic sanctions would have emerged were it not for the smaller individual sanctions placed on South Africa?

Socially responsible investment's other major success was the Valdez Principles (Appendix B), a set of environmentally friendly guidelines established in 1990 that companies may adopt. Companies that adopt these principles signal to investors that they are environmentally friendly; whether or not they follow through on their promises, only time can tell. However, it can be a differentiating factor between two different companies in helping an investor decide where to place his funds. In line with most environmentally friendly practices, the Valdez Principles provide economic benefit by helping to distribute resources, especially non-renewable resources, across time. Environmental socially responsible investment aims to preserve resources, and the Earth, for future generations. In the present day, if a company adopted and followed the Valdez Principles, it would contribute to that company's environmental, social, and governance (ESG) score.

Modern day SRI has three forms: shareholder activism, guideline portfolio investment, and community development investing (Shapiro 1992, p. 5). Shareholder activism involves using publicly traded shares of a company to try and effect change within said company's management, typically through corporate voting. An activist shareholder would generally try to obtain representation on the board of directors or assume a large enough ownership position in the company to bring forth a motion. There are many types of shareholder activism and not all are necessarily socially responsible in the context of this paper.

Guideline portfolio investment is self-explanatory and involves setting rules for a portfolio and then following them. Guideline portfolio investment does not have to be socially responsible, but it is one of the tools which socially responsible investors can use. An SRI guideline might be ‘do not invest in tobacco companies.’ These guidelines can involve both negative and positive screening as the strategies are not mutually exclusive. This form of modern day socially responsible investment is the primary focus of this paper. Much of the historical forms of socially responsible investment we have seen were guideline portfolio investment and community development investment.

Community development investing might involve investing in parks or schools for local communities. It sometimes refers to investment in poor communities; examples range in size and scope and include affordable housing, food drives/pantries, or urban renewal projects. This paper does not address the efficacy of community development or community investment, nor does it attempt to analyze the returns of community development investing but does include it as a tool that some socially responsible investors use.

LITERATURE REVIEW

Socially responsible investment (SRI) is a subset of portfolio management. Some people interpret it as a form of active management while others view it as passive, rules-based investing. Therefore, much of the literature is focused on case studies and performance measurements. The literature is generally diverse and provides evidence for outperformance of both ethical funds and 'sin' based funds.

Jonas Nilsson (2008) examines investor attitude and perceived financial performance of SRI funds in Sweden. The author conducted a survey of 2200 Swedish mutual fund investors in order to determine investor attitude towards socially responsible investments; he collected data "regarding age, gender, place of residence, income, and education" (Nilsson 2008, p. 314). He also collected data regarding SRI characteristics, pro-social attitudes, and the percentage of total portfolio invested in SRI funds. He found that a majority of investors, 72.9%, perceived a similar or higher return of SRI funds relative to normal funds, and that 84.7% perceived a similar or lower risk of SRI funds relative to normal funds (p. 317). The author then ran a regression to see how the foregoing characteristics affected what percentage of their portfolio investors placed into SRI funds. He found that "perception of return is significantly related to SR-investment" and that "…people with high levels of pro-social attitudes…were more likely to invest a greater proportion of their portfolio in SRI profiled mutual funds" (p. 319). Nilsson's research indicates that investors have both financial and social motivations for investing in socially responsible funds. The greater the cause premium, consisting of both financial and social gain, the more likely an individual is to invest in a cause. His research does not hint at the existence of a cause premium, but rather indicates that investors are amenable to cause-based investing if the financial returns are similar to traditional investing.

In an effort to explore the cause premium further, we turn to Berry and Yeung (2013) to investigate investor willingness to further support socially responsible causes. They use a postal questionnaire, sent to existing ethical clients of an investment firm, to gauge whether investors will avoid ethical funds if a financial penalty exists for acting ethically. The clients were asked to allocate a hypothetical £100,000 among financial and ethical portfolios. The clients were grouped into three categories based on their responses to the survey: materialistic (35%), opportunistic (11%), and committed (54%) (Berry and Yeung 2013, p. 485). Materialistic investors preferred financial gain to ethical gain, opportunistic investors were indifferent between financial and ethical gain, and committed investors preferred ethical gain to financial gain. These results strongly support the existence of a mental cause premium. A majority of respondents remained committed to their ethical investing strategies even though a larger financial gain could be had. Their research is also indicative that the mental premium is not as large as I believe it to be; the flip side to my previous statement is that 35% of respondents broke with the ethical investment strategy to secure further financial gain. Further research extending Berry and Yeung's work could help to quantify the mental cause premium.

Humphrey, Warren and Boon (2016) investigate how socially responsible funds differ from traditional funds. The authors analyzed manager characteristics and fund performance of socially responsible and non-socially responsible funds. They found that socially responsible funds are not significantly different from non-socially responsible funds, in both manager characteristics and performance related measures. The authors' results indicate that this paper's socially responsible fund should not be inferior, financial return-wise, to the underlying index. If these results are accurate, then investors should benefit by investing in a cause-based fund, since they will harness the proposed mental cause premium.

Statman and Glushkov (2016) investigate the financial return of socially responsible funds. They use a six factor model: (1) small-large capitalization, (2) value-growth, (3) momentum, (4) market returns in excess of treasury bills, S&P500 returns in excess of treasury bills, KLD 400 return in excess of treasury bills, (5) 'top-bottom factor' (TMB) and (6) 'accepted-shunned factor' (AMS) (Statman and Glushkov 2016, p. 144). Overall, their model found no statistically significant outperformance of socially responsible companies (p. 148). Of interest are their TMB and AMS factors. TMB is essentially a positive screen, where investors seek out companies with pro-social factors and AMS is a negative screen, where investors shun negative characteristics. The authors find that TMB provides statistically significant positive alpha to a fund's return while AMS provides statistically insignificant negative alpha to a fund's return (p.149). Their research bodes poorly for this paper's socially responsible fund; since I am utilizing a negative screen, I should end up with negative alpha associated with the AMS factor. The general problem in this field, illustrated in Statman and Glushkov (2016) but not specific to them, is the lack of statistical significance of most performance measures.

Fernandez-izquierdo and Matallin-saez (2008), Bertrand and Lapointe (2015), and Mallin and Briston (1995) all analyze the performance of ethical investment funds relative to traditional investment funds. They all generally find that socially responsible funds have slightly superior returns, but they fail to achieve statistical significance in their return measures.

Trinks and Scholten (2017) provide evidence to the contrary. They use mean-variance analysis to analyze the performance of 'sin portfolios' relative to the market and of negatively screened portfolios relative to the market (Trinks and Scholten 2017, p. 195, 200). They find that sin portfolios statistically outperform the market, while negatively screened portfolios statistically underperform. Different sins have different levels of (out)performance, primarily due to their size; for example, negatively screening alcohol results in a significant decrease in overall market capitalization relative to negatively screening adult entertainment (p. 201-202). Trinks and Scholten make a strong case for the outperformance of ‘sin portfolios’ and the underperformance of negatively screened portfolios. Restricting the investment universe naturally makes a portfolio less diversified and generally reduces risk-adjusted performance measures. The main issue with Trinks and Scholten is that their analysis is for a single time period of 1991-2012, with no sub-period analysis. Return analysis is, in general, highly sensitive to the time period being analyzed. They would make a more compelling argument with a larger case study involving sub-period analysis.

I field an additional argument from Adler and Kritzman (2008) regarding the underperformance of socially responsible investment. Adler and Kritzman perform Monte Carlo analysis to simulate the returns of restricted investment portfolios, a proxy for a socially responsible fund (Adler and Kritzman 2008, p. 53-4). The authors find that the greater the skill an investor has, the higher the opportunity cost to restricting their investment universe (Adler and Kritzman, p. 55). A restricted investment universe is a common argument used to oppose socially responsible investment. The authors make a strong case that a highly skilled investor incurs an opportunity cost when restricting his investment universe. The problem with their study lies with the ‘skill’ factor and the inclusion of some costs but not others. The authors are clearly writing about institutional investors, as their baseline portfolio value is $1 billion. This paper targets a much smaller, likely non-institutional, investor. As such, the skill level of this paper’s investor declines, most likely to chance or sub-chance levels. It is therefore highly unlikely these unskilled investors have an opportunity cost; in fact, the authors’ own paper indicates that at a 50% correctness level, investors realize a gain by restricting their investment universe (Adler and

Kritzman, p. 55). Furthermore, the calculation of opportunity cost in this paper is purely financial. It does not take into account gains from less pollution, less environmental damage, fewer gun deaths, etc. that may be realized from significant investment in socially responsible funds.

MEASURES OF PERFORMANCE

Harry M. Markowitz, William F. Sharpe, Jack L. Treynor, Michael C. Jensen, and Eugene Fama all made seminal contributions to the field of portfolio management and analysis. Most of the other papers involving SRI use their analytical framework to assess socially responsible portfolios. Markowitz (1952) provides the framework for choosing a portfolio. His work demonstrates that investors should not only be concerned with total return of a portfolio but also with the variance of those returns. Through the use of geometric proofs, he describes a set of 'efficient portfolios,' for which variance is minimized while return is maximized (Markowitz 1952, p. 87). Speaking plainly, Markowitz identifies portfolios for which an investor receives the greatest return for the risk he takes. This type of analysis, mean-variance analysis, is the primary system this paper uses to assess the performance of the three funds (socially responsible, underlying index, sin fund) and five random funds. This paper will not remark on whether or not a fund is efficient in a global sense, but rather whether or not a fund is efficient relative to the other funds being measured.

William F. Sharpe's *"The Sharpe Ratio"* (1994) remarks on his ratio and its potential uses for mean-variance analysis. His ratio may be used both ex ante and ex post; this paper will use the ex-post ratio, defined as:

$$S_h \equiv \sqrt{\frac{\bar{D}}{\sigma_D}} \qquad (1)$$

Sharpe (1994, p. 50, equation 6). S_h is the ex-post Sharpe Ratio, $\overline{D}$ is the average value of the return of a fund in excess of the risk-free rate, and σ_D is the standard deviation of the fund. The ratio "indicates the historic average differential return per unit of historic variability of the differential return" (Sharpe 1994, p. 50). A higher Sharpe ratio indicates greater return for a given level of risk. In Markowitz's terms, a higher Sharpe ratio would indicate a more efficient portfolio. The Sharpe Ratio will thus allow for an ordinal ranking of the three funds. As a test of the statistical significance of the Sharpe Ratio, I use the method outlined in Bailey and Lopez de Prado (2012).

The Treynor ratio is an additional ordinal ranking measure. It is designed to measure return in excess of market return. Its general form is $T \equiv \frac{r_i - r_f}{B_i}$, where T is the Treynor ratio, r_i is the return of the fund, r_f is the risk-free rate and B_i is the beta of the portfolio (covariance with the market) (Treynor 1965). B_i will use the SP500 for the market when calculating the covariance between my funds and the 'market.' This would mean that the underlying index will have B = 1; the socially responsible portfolio will also have a B near 1.

While the previous measures allow for ordinal ranking between funds, Michael C. Jensen's alpha (1968) is a measure which represents the financial gain from a particular strategy. Jensen's alpha is defined as:

$$\alpha_j \equiv R_i - \left[R_f + \beta_{iM} * \left(R_M - R_f\right)\right] \tag{2}$$

(Jensen 1968, p. 400, equation 8). α_j is Jensen's alpha, R_i is the return of the portfolio, R_f is the risk-free rate, β_{iM} is the beta (covariance) of the portfolio with the market, and R_M is the return of the market. This paper will use historical 90-day Treasury Bill rates for the risk-free rate (R_f) and use historical average S&P 500 6 month returns for beta and market return. Note that one of the three portfolios studied in this paper, the underlying index, will have an alpha of zero. A positive alpha for the SRI portfolio is evidence of a cause premium. A negative alpha for the SRI portfolio is evidence of a cause sacrifice.

Note also that Jensen's alpha can be rewritten as a regression equation:

$$R_i - R_f = \alpha_j + \left[\beta_{iM} * \left(R_M - R_f\right)\right] + \in \quad (3)$$

Where the excess return of the portfolio relative to the risk-free rate is regressed on the excess return of the market relative to the risk-free rate. Jensen's alpha is the y-intercept of this regression.

DATA AND METHODOLOGY

Data of the historical constituents in the SP500 is taken from the Bloomberg terminal (and ultimately is from Thomson Reuters), through their SPX <Index> MEMB <GO> function. A custom screen of ticker, price, GICS sub-industry identifier, and market capitalization is generated and imported into Microsoft Excel. The data is taken for the period of 1990-2018. From this list, I screen for and remove the GICS sub-industry companies outlined in Appendix A, Table 1. This screen was constructed with religious-historical preferences in mind, i.e. screen for alcohol, tobacco, gambling, weapons, and environmental health (oil). Application of the negative screen resulted in an ethical portfolio of average size 481 and an unethical portfolio of average size 19 over the time period. The risk-free rate of return used is the 3-month treasury bill (T-bill), available online at the US Treasury website.

Once the foregoing industries are removed, I separate the three funds by composition. I then sum the market capitalization of the individual companies within the three funds. This process is repeated for the data every 6 months, from January 1st, 1990 until June 31st, 2018. Of note is that I track the performance of each fund for a 6-month period (the holding period) and, at the end of the period, screen the SP500 again to re-form the three funds. This process generates 56 data points representing market capitalizations of the socially responsible fund, the unethical fund, and the SP500 at 6-month intervals. Using these data points, I calculate the total return for every period across all 28 years, resulting in 55 return data points. Dividends are not included in this analysis; this may impact the results, particularly because the negatively screened industries generally provide higher dividend yields than the remaining industries. Table 1.1 on the following page summarizes the above information.

Table 1.1: Descriptive Statistics; Returns by Portfolio

Portfolio	Obs	No. Comp.	Mean	Geo. Mean	Std.Dev.	Min	Max	Skew.	Kurt.
SP500	55	1260	.051	0.045	.1	-.35	.208	-1.159	6.074
Ethical	55	1118	.051	0.045	.102	-.351	.211	-1.128	5.937
Sin	55	36	.058	0.050	.131	-.323	.384	-.416	4.471
Ran1	55	36	.074	0.062	.152	-.486	.422	-.745	5.314
Ran2	55	19	.129	0.087	.424	-.328	2.391	4.335	22.161
Ran3	55	35	.055	0.045	.142	-.5	.484	-.645	6.794
Ran4	55	28	.088	0.077	.151	-.324	.642	.427	6.056
Ran5	55	22	.155	0.092	.608	-.389	4.35	6.139	42.792

Note: All observations are within the time period 1990-2018.

These returns are then annualized, and the annualized returns are used to calculate the total returns, Sharpe Ratios, and alphas of the three funds. Total return for the period is calculated by computing the geometric mean of the returns. The alpha is generated by regressing the excess return of the fund on the excess return of the market, as shown in equation 3; the constant term in the regression is the alpha of the fund. Sharpe Ratios are calculated by dividing the arithmetic mean of the excess-return of the portfolio by the portfolio excess-return's standard deviation. This provides a best case upper-bound for the Sharpe Ratio and is primary reason why the arithmetic mean is used rather than the geometric mean. As a check on the robustness of these results, further analysis is undertaken to examine whether or not any outliers are driving the returns of either portfolio; returns of specific companies within the sin portfolios are also generated across all periods and tracked. Any company exceeding $1/20^{th}$ of the total portfolio return for that period is marked, removed, and then the total returns of the portfolios are recalculated.

Finally, as an additional robustness check, random portfolios are also generated by randomly sampling 5 GICS codes and then screening out those companies from the portfolio. These random portfolios are then compared to the ethical, sin, and market portfolios. These portfolios are created due to the relatively small size of the sin portfolio; rather than comparing a portfolio of size 18 to a portfolio of size 482, the sin portfolio can be compared more fairly (particularly on a risk-adjusted basis) to other portfolios of similar size. The process by which the returns are calculated, as well as outlier identification and removal, is the same as in the foregoing paragraph. Table 1.2 on the following page summarizes the regression results for the pre-outlier portfolios.

For specific, step-by-step reference for how these returns were calculated, see Appendix C for the Stata Do-files and corresponding Stata output. All of the Stata output was generated on a Late 2011 MacBook Pro, macOS High Sierra, Version 10.13.6. Stata Version 15.1 for Mac, 64 bit.

RESULTS AND ANALYSIS

The unethical portfolio was more volatile and, while it had a higher absolute return, had a lower risk-adjusted return relative to the ethical and market portfolios. The unethical portfolio similarly had a greater alpha than that of the ethical portfolio; however, the alpha of both strategies was statistically insignificant.

Figure 1 in Appendix A Table 1.2 on the following page shows the performance of the separate funds; Figure 1 is an indicator of the excess volatility (of the unethical portfolio) incurred by negatively screening the SP500 (i.e., restricting the investment set). Figure 1 further indicates that the unethical portfolio outperforms the other investment strategies. Table 1.2 on page 23 quantifies the visual; we see that the sin portfolio outperforms the market and ethical portfolios in absolute terms, but when adjusting the annualized returns for risk, underperforms the ethical and SP500 portfolios (i.e. has a lower Sharpe Ratio). Table 1.2, the regression results of excess return of the portfolios on excess return of the market, indicate that both the ethical and sins' alphas are statistically insignificant; neither strategy yields an excess return that is statistically different from zero.

In Table 1.2, we see that the ethical portfolio is nearly identical to the SP500 in returns; a more robust screening procedure must be used to adequately screen companies from the SP500. It is likely that rather than screening only unethical companies, ethical companies should also be screened. Additionally, a more robust screening procedure, such as one that incorporates Environmental, Social, and Governance ("ESG") scores for each company (i.e. a movement towards a factor-based screening), another MSCI-owned measure this paper discovered while using their GICS sub-sectors; a transition from sub-sectors to ESG scores would be a marked methodological improvement over the methods used in this study.

It is also possible that the SP500 is already too restricted an investment set to solely negatively screen unethical companies. Macroeconomic trends have made the SP500 more "ethical" in the traditional sense of the term; fewer polluters are capable of making it into the SP500, which makes screening companies by sector a suboptimal strategy. A trend towards services and technology has made the SP500 more "green," or environmentally friendly, over time. M&A activity, particularly reverse mergers, has further removed traditionally 'unethical' companies from the SP500, i.e. taken them private or merged them with a larger umbrella, which hinders the ability to determine if said umbrella is 'unethical'. Further research is required to determine whether or not the SP500 can be effectively screened for superior performance.

The random portfolios, Random 1 through Random 5, also have insignificant alpha with the exception of Random 4, which is significant at the 5% level. The returns vary from 9% to 19% for each of the portfolios, and the Sharpe ratios similarly vary from 0.25 to 0.49 (not corresponding 1:1 to the prior range). Looking at each individual portfolio, Random 1 had an absolute return slightly in excess of the market, ethical, and sin portfolios. Its volatility was similar to that of those portfolios as well, as evidenced by the similar Sharpe Ratio of 0.49. Random 1's alpha was not statistically significant. Random 2 had a large absolute return and alpha, but this return generated excess volatility as well, as seen by its Sharpe Ratio of 0.30. Again, Random 2's alpha was not statistically significant. Random 3 had a similar absolute return to the market but exhibited greater volatility (Sharpe Ratio 0.39). Random 4 was the only portfolio with a significant alpha (at 4.4% of the return attributable to the strategy). Its absolute return was in excess of the market and it exhibited less volatility relative to its return as well (Sharpe Ratio of 0.58). Random 5 had the highest absolute return at 19.33%; however, it had extreme volatility (Sharpe Ratio 0.25). Overall, the random portfolios did not outperform the market on a risk-adjusted basis; in general, a higher absolute return was accompanied by ever increasing risk for that higher return. Lack of statistical significance, of course, prevents much judgment on the efficacy of certain strategies relative to each other. The table below summarizes the regression results of each portfolio before any outliers are handled.

Table 1.2 : Regression results, Excess Return of Portfolio on Excess Return of Market, Pre-Outlier

	(1) (Ethical)	(2) (Sin)	(3) (Ran1)	(4) (Ran2)	(5) (Ran3)	(6) (Ran4)	(7) (Ran5)
exc_mkt	1.010***	0.672***	1.267***	1.773***	1.071***	0.863***	0.388
	(0.004)	(0.154)	(0.113)	(0.526)	(0.126)	(0.169)	(0.830)
_cons	-0.001	0.024	0.010	0.040	0.001	0.044**	0.135
	(0.000)	(0.017)	(0.013)	(0.059)	(0.014)	(0.019)	(0.093)
Obs.	55	55	55	55	55	55	55
R-squared	0.999	0.264	0.703	0.176	0.578	0.330	0.004

Standard errors are in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

The in-depth regression results for the previous paragraphs may be found in Appendix A, Tables 2 through 8. Table 9 summarizes the regression results as well as return data from Appendix C, pp. C-1 to C-12. How the random portfolios were generated, and the steps by which to replicate this process, may be found in Appendix C, pp. C-13 to C-15. Table 17 on p. C-15 highlights the seeds used in generating the random portfolios for quick reference. This concludes the standard analysis; outlier analysis follows.

Robustness

Next, I analyzed each screened portfolio for outliers, such as the Sin and Random 1 through 5 portfolios, removed those outliers (if they existed), and then repeated the analysis for outlier free portfolios. A company as considered an outlier if, for at least two periods, its return was greater than 1/20th the return of the entire portfolio for those periods (i.e. a 'size' outlier). This had similar (identical) results to flagging companies based on their return exceeding 3 standard deviations of the portfolio return; since the prior strategy is simpler to implement in

Stata, it was chosen over the latter strategy. A size outlier is removed from all periods; we will discuss the implications of this later. Appendix C, Output 3, pp. C-16 to C-18 outlines the specific, step-by-step instructions for identifying and removing outliers from a portfolio. Figures 3 through 8, Appendix C, pp. C-20 to C-23 identify the outliers removed from their respective portfolio.

Table 1.3 below shows the performance of the separate portfolios; immediately apparent is that Random 2 tremendously outperforms the other portfolios, and Random 5 suffers nearly a total loss early on. It also appears as though the performance of the portfolios that had outliers removed generally increased (barring, of course, the total loss). Table 1.3 below also summarizes the returns of the set of portfolios. Most portfolios again have insignificant alpha; of note is that the volatility of the portfolios generally seemed to decline as a result of removing the outliers (i.e. most Sharpe Ratios seemed to increase). Also of note is that the post-outlier Sin portfolio has a significant alpha and exhibits superior absolute and risk-adjusted return, relative to its pre-outlier self as well as to the market and ethical funds.

Table 1.3 : Regression results, Excess Return of Portfolio on Excess Return of Market, Post-Outlier

	(1) (Sin)	(2) (Ran1)	(3) (Ran2)	(4) (Ran3)	(5) (Ran4)	(6) (Ran5)
exc_mkt	0.793***	1.100***	2.328*	0.601***	0.939***	3.956
	(0.150)	(0.112)	(1.290)	(0.151)	(0.235)	(3.412)
_cons	0.035**	0.006	0.105	0.029*	0.053**	0.230
	(0.017)	(0.013)	(0.144)	(0.017)	(0.026)	(0.381)
Obs.	55	55	55	55	55	55
R-squared	0.344	0.645	0.058	0.231	0.231	0.025

Discussion

The prior results are likely due to some element of survivorship bias being introduced to the analysis as a result of removing outliers across all periods; this transforms the problem from an ex-ante analysis into an ex-post manipulation of the results. Even if an outlier is removed in an ex-ante fashion, i.e. an outlier is flagged in one period, t, is then removed in the next period, t + 1, then (possibly) reintroduced in time period t+2, this treatment is still questionable as it changes the fundamental investment strategy (which, for this paper, is buy-and-hold with rebalancing). A better design choice would be to control for size rather than accommodate size as an outlier, such as in the common Fama-French 3- and 5-factor models (Fama and French, 1992, 2014). Another treatment, which was taken into account in this paper, is to incorporate the volatility into the return itself, a-la Sharpe's Ratio. Handling of outliers through removal begs a further question: when is it good enough to stop? One round of outlier removal could result in a second round, which could result in a third, etc. It's unclear how many rounds are 'acceptable' or 'methodologically sound;' rather, controlling for size (or controlling for changes in volatility implied by having a size outlier) is a sounder design choice.

The regression results for the post-outlier analysis are in Appendix A, Tables 10 through 15. Table 16 summarizes the results found in the regressions and Appendix C, pp. C-16 to C-23. The specific outliers removed are shown in Appendix C, Figures 3 through 8.

The overall results for this paper are in-line with other literature reviewed; my results are in line with Fernandez-izquierdo and Matallin-saez (2008), Bertrand and Lapointe (2015), Statman and Glushkov (2016), Humphrey, Warren and Boon (2016), and Mallin and Briston (1995). The foregoing papers fail to find statistically significant returns.

Limitations

Not including dividends is a significant methodological decision that could impact these results. It is possible that, with dividend inclusion (and reinvestment), the alpha of one or more strategies either improves or becomes significant. This analysis does not include any sort of cash flow constraint either; for example, assume that the return from period 3 to period 4 is -50%. In this paper's strategy, there is a rebalancing from the end of period 3 to the start of period 4. However, there may not be enough cash in the fund to rebalance and purchase the requisite shares after incurring a 50% loss. The failure to consider cash flow constraints could, again, significantly impact the practical implications of this paper.

Another significant methodological improvement successive studies should incorporate is to screen using some combination of socially responsible factors, rather than screening by subsector. For example, Altria is an enormous cigarette manufacturer and would be screened out in this paper's study. However, it is also one of the larger employers of women and minorities, both on an absolute level and on a relative scale (i.e. they employ a 'balanced' amount of men and women). While transitioning to a factor-based screening method would then beg the question of who is creating and evaluating the socially responsible factors, this is still likely to be a more robust screening method than crudely screening by industry sector.

The statistical insignificance of most of the strategies is likely attributable to the smaller sample size used in generating the portfolio returns (i.e. every 6 months). While this time period was chosen for tractability reasons, at 55 observations it likely limited the explanatory power of this paper's analysis. A more frequent sampling period (i.e. monthly, weekly, daily, etc.) would result in a more robust analysis; replication with access to more frequent sampling periods, and dividends, would be an interesting subsequent project.

All of the prior methodological issues present severe limitations for the results of this paper. The tractability assumptions made in this paper, such as the lack of dividend inclusion, a 6-month sampling period, and sub-sector screening, greatly handicap the findings herein. These results should not be used to provide investment advice to any individuals, should not be generalized, and should not be used for policy decisions.

Statistical insignificance means that I cannot state whether one strategy is superior (inferior) to the other; however, this outcome actually bodes well for socially responsible investment. Choosing to ethically screen the SP500 does not have a significantly different impact on the investment returns; thus, investors may harvest an ethical or ‘feel-good’ premium without necessarily sacrificing performance.

CONCLUSION

This paper analyzed a negatively screened S&P500 'socially responsible fund' from 1990-2018. I find evidence that socially responsible investment has inferior absolute return but superior risk-adjusted returns relative to unethical investment. Neither return attributable to the strategy was statistically significant. Thus, this paper fails to provide evidence for the argument that socially responsible investment is superior to traditional investment strategies. These implications are typical in the literature, in the sense that most papers on the topic are either contradictory or fail to find significant returns. Nevertheless, fund managers should consider offering, and investors should similarly consider, a broad variety of socially responsible funds, in order to provide an outlet for an 'ethical' or 'feel-good' premium and similar financial return to other funds.

Appendix A: Quick Reference Tables and Figures

Table 1: GICS Sub-Industry Screening

Industry	Sub-Industry Name	Sub-Industry (GICS Identifier)
Oil, Gas & Consumable Fuels		
	Coal & Consumable Fuels	10102050
	Oil & Gas Storage & Transportation	10102040
Aerospace & Defense		
	Aerospace & Defense	20101010
Hotels, Restaurants, and Leisure		
	Casinos & Gaming	25301010
Beverages		
	Brewers	30201010
	Distillers & Vintners	30201020
Tobacco		
	Tobacco	30203010

Descriptions of the sub-industries (found at: https://www.msci.com/gics):

Coal & Consumable Fuels (10102050): "Companies primarily involved in the production and mining of coal, related products and other consumable fuels related to the generation of energy. Excludes companies primarily producing gases classified in the Industrial Gases sub-industry and companies primarily mining for metallurgical (coking) coal used for steel production." (MSCI).

Oil & Gas Storage & Transportation (10102040): "Companies engaged in the storage and/or transportation of oil, gas and/or refined products. Includes diversified midstream natural gas companies facing competitive markets, oil and refined product pipelines, coal slurry pipelines and oil & gas shipping companies." (MSCI).

Aerospace & Defense (20101010): "Manufacturers of civil or military aerospace and defense equipment, parts or products. Includes defense electronics and space equipment." (MSCI)
Casinos & Gaming (25301010): "Owners and operators of casinos and gaming facilities. Includes companies providing lottery and betting services." (MSCI)
Brewers (30201010): "Producers of beer and malt liquors. Includes breweries not classified in the Restaurants Sub-Industry." (MSCI)
Distillers & Vintners (30201020): "Distillers, vintners and producers of alcoholic beverages not classified in the Brewers Sub-Industry." (MSCI)
Tobacco (30203010): "Manufacturers of cigarettes and other tobacco products." (MSCI)

Figure 1: Return of $100,000 from 1990-2018; Pre-Outlier

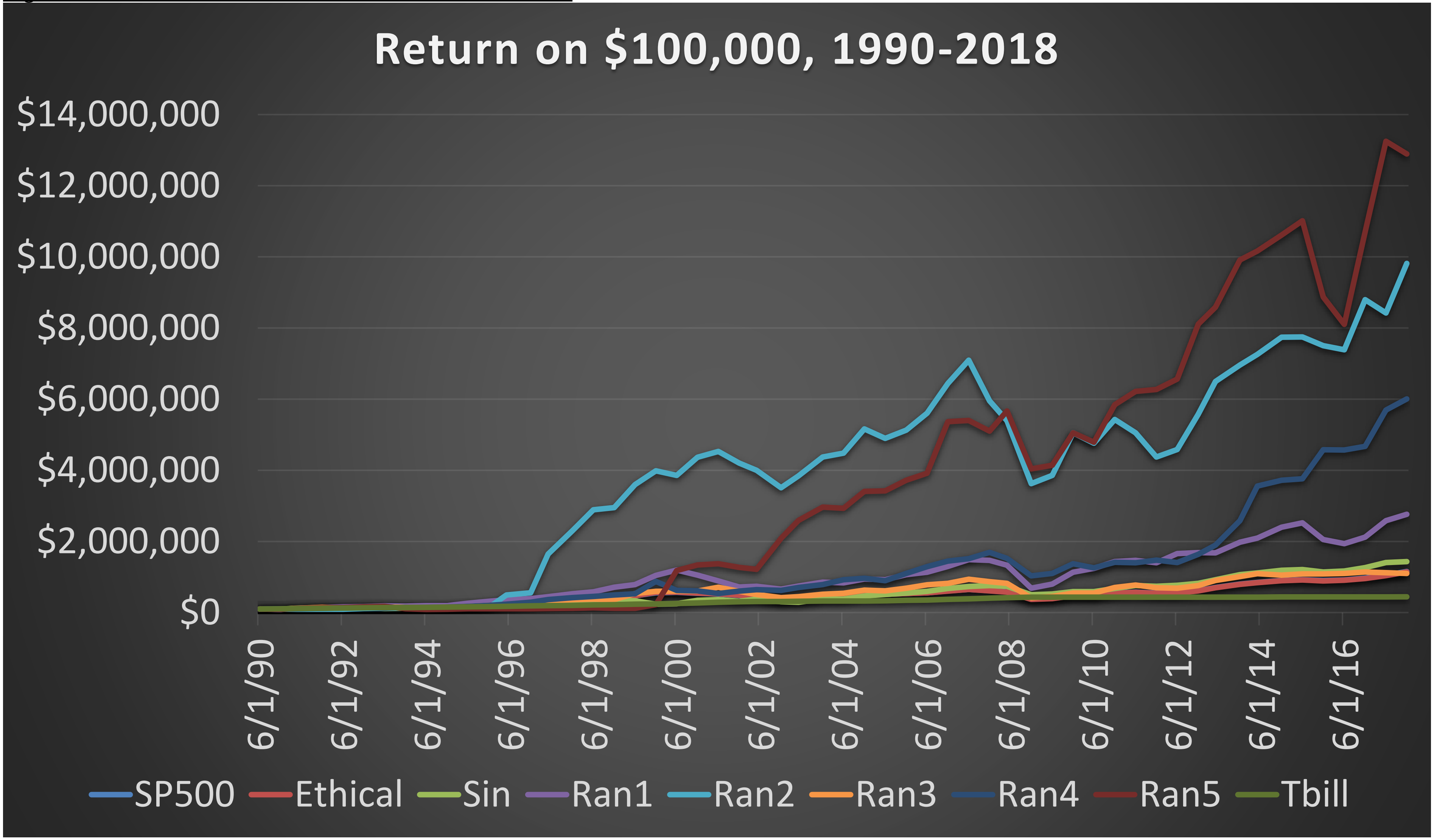
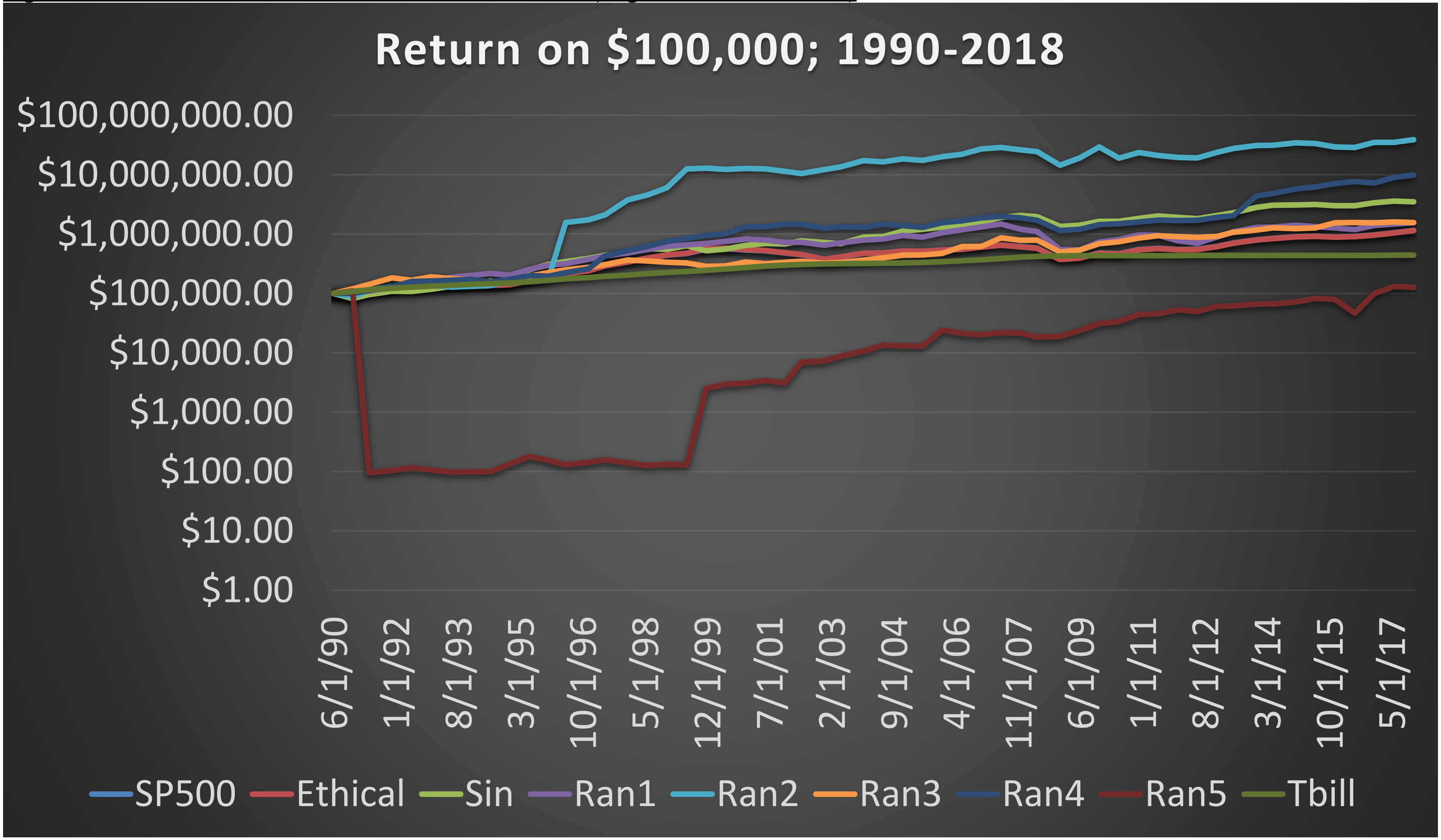


Figure 2: Return of $100,000 from 1990-2018; Post-Outlier (Log-Scaled Vertical Axis)



.

Table 2: Ethical Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
182 .
183 . // CAPM regressions for all of the portfolios.
184 . // Ethical portfolio
185 . reg (exc_eth) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =  51750.60
       Model |  .555704207         1  .555704207   Prob > F        =    0.0000
    Residual |  .00056912         53  .000010738   R-squared       =    0.9990
-------------+----------------------------------   Adj R-squared   =    0.9990
       Total |  .556273327        54  .010301358   Root MSE        =    .00328

------------------------------------------------------------------------------
     exc_eth |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   1.009783   .0044388   227.49   0.000      1.00088    1.018686
       _cons |   -.000567   .0004953    -1.14   0.257    -.0015605    .0004264
------------------------------------------------------------------------------
```

Table 3: Sin Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
186 . // Sin portfolio
187 . reg (exc_sin) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     19.00
       Model |  .246249868         1  .246249868   Prob > F        =    0.0001
    Residual |  .686987578        53   .01296203   R-squared       =    0.2639
-------------+----------------------------------   Adj R-squared   =    0.2500
       Total |  .933237446        54  .017282175   Root MSE        =    .11385

------------------------------------------------------------------------------
     exc_sin |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   .6721932   .1542207     4.36   0.000     .3628657    .9815208
       _cons |   .0239978   .0172083     1.39   0.169    -.0105177    .0585134
------------------------------------------------------------------------------
```

Table 4: Random 1 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
188 . // Random 1 portfolio
189 . reg (exc_ran1) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =    125.32
       Model |  .875104603         1  .875104603   Prob > F        =    0.0000
    Residual |  .370096129        53  .006982946   R-squared       =    0.7028
-------------+----------------------------------   Adj R-squared   =    0.6972
       Total |  1.24520073        54  .023059273   Root MSE        =    .08356

------------------------------------------------------------------------------
    exc_ran1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   1.267174   .1131945    11.19   0.000     1.040134    1.494213
       _cons |   .0100519   .0126305     0.80   0.430    -.0152818    .0353855
------------------------------------------------------------------------------
```

Table 5: Random 2 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
190 . // Random 2 portfolio
191 . reg (exc_ran2) (exc_mkt)
```

Source	SS	df	MS
Model	1.71321486	1	1.71321486
Residual	8.00040784	53	.150951091
Total	9.7136227	54	.179881902

Number of obs	=	55
F(1, 53)	=	11.35
Prob > F	=	0.0014
R-squared	=	0.1764
Adj R-squared	=	0.1608
Root MSE	=	.38852

exc_ran2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
exc_mkt	1.773014	.526289	3.37	0.001	.7174115	2.828616
_cons	.0396247	.0587246	0.67	0.503	-.078162	.1574114

Table 6: Random 3 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
192 . // Random 3 portfolio
193 . reg (exc_ran3) (exc_mkt)
```

Source	SS	df	MS
Model	.625626615	1	.625626615
Residual	.456134521	53	.008606312
Total	1.08176114	54	.020032614

Number of obs	=	55
F(1, 53)	=	72.69
Prob > F	=	0.0000
R-squared	=	0.5783
Adj R-squared	=	0.5704
Root MSE	=	.09277

exc_ran3	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
exc_mkt	1.07143	.1256651	8.53	0.000	.8193776	1.323482
_cons	.0009283	.014022	0.07	0.947	-.0271963	.029053

Table 7: Random 4 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
194 . // Random 4 portfolio
195 . reg (exc_ran4) (exc_mkt)
```

Source	SS	df	MS
Model	.406173416	1	.406173416
Residual	.822795983	53	.015524453
Total	1.2289694	54	.022758693

Number of obs	=	55
F(1, 53)	=	26.16
Prob > F	=	0.0000
R-squared	=	0.3305
Adj R-squared	=	0.3179
Root MSE	=	.1246

exc_ran4	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
exc_mkt	.8633003	.1687774	5.12	0.000	.5247757	1.201825
_cons	.043877	.0188326	2.33	0.024	.0061036	.0816504

Table 8: Random 5 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
196 . // Random 5 portfolio
197 . reg (exc_ran5) (exc_mkt)
```

Source	SS	df	MS
Model	.082190809	1	.082190809
Residual	19.8819398	53	.375130939
Total	19.9641306	54	.369706122

Number of obs	=	55
F(1, 53)	=	0.22
Prob > F	=	0.6416
R-squared	=	0.0041
Adj R-squared	=	-0.0147
Root MSE	=	.61248

exc_ran5	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
exc_mkt	.388345	.8296551	0.47	0.642	-1.275732	2.052422
_cons	.1347765	.092575	1.46	0.151	-.0509054	.3204584

Table 9: Summary Table of Regression Results, Pre-Outlier

Portfolio	Return (G. Mean)	Alpha	Significant (Level)	Sharpe Ratio	No. Outliers
Market	9.3%	-	-	0.50	-
Ethical	9.26%	0%	N	0.50	-
Sin	10.16%	2.4%	N	0.44	6
Random 1	12.82%	1.0%	N	0.49	6
Random 2	18.14%	4.0%	N	0.30	6
Random 3	9.12%	1.0%	N	0.39	9
Random 4	16.06%	4.4%	Y (0.05)	0.58	7
Random 5	19.33%	13.5%	N	0.25	7

Information assembled from Appendix C, pp. C-1 to C-12.

Table 10: Sin Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
36 .
37 . // CAPM regressions for all of the portfolios.
38 . // Sin portfolio
39 . reg (exc_sin) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     27.80
       Model |  .342977171         1  .342977171   Prob > F        =    0.0000
    Residual |  .653785806        53  .012335581   R-squared       =    0.3441
-------------+----------------------------------   Adj R-squared   =    0.3317
       Total |  .996762977        54  .018458574   Root MSE        =    .11107

------------------------------------------------------------------------------
     exc_sin |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   .7931597   .1504208     5.27   0.000     .4914538    1.094866
       _cons |   .0348752   .0168056     2.08   0.043     .0011675    .0685829
------------------------------------------------------------------------------
```

Table 11: Random 1 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
37 .
38 . // CAPM regressions for all of the portfolios.
39 . // Sin portfolio
40 . reg (exc_ran1) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     96.38
       Model |  .659431821         1  .659431821   Prob > F        =    0.0000
    Residual |  .362618706        53  .006841862   R-squared       =    0.6452
-------------+----------------------------------   Adj R-squared   =    0.6385
       Total |  1.02205053        54  .018926862   Root MSE        =    .08272

------------------------------------------------------------------------------
    exc_ran1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |     1.0998   .1120253     9.82   0.000     .8751059    1.324494
       _cons |    .005719   .0125157     0.46   0.650    -.0193844    .0308223
------------------------------------------------------------------------------
```

Table 12: Random 2 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
21 .
22 . // CAPM regressions for all of the portfolios.
23 . // Ran2 portfolio
24 . reg (exc_ran2) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =      3.26
       Model |   2.9551886         1   2.9551886   Prob > F        =    0.0767
    Residual |  48.0598527        53  .906789674   R-squared       =    0.0579
-------------+----------------------------------   Adj R-squared   =    0.0402
       Total |  51.0150413        54  .944722988   Root MSE        =    .95226

------------------------------------------------------------------------------
    exc_ran2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   2.328206    1.28968     1.81   0.077    -.2585652    4.914977
       _cons |    .105363   .1440861     0.73   0.468    -.1836371     .394363
------------------------------------------------------------------------------
```

Table 13: Random 3 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
. 
. // CAPM regressions for all of the portfolios.
. // Ran3 portfolio
. reg (exc_ran3) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     15.91
       Model |  .197196397         1  .197196397   Prob > F        =    0.0002
    Residual |  .656904237        53   .01239442   R-squared       =    0.2309
-------------+----------------------------------   Adj R-squared   =    0.2164
       Total |  .854100634        54  .015816678   Root MSE        =    .11133

------------------------------------------------------------------------------
    exc_ran3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   .6014206    .1507794     3.99   0.000     .2989955    .9038457
       _cons |   .0285168    .0168454     1.69   0.096    -.0052708    .0623045
------------------------------------------------------------------------------
```

Table 14: Random 4 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
. // CAPM regressions for all of the portfolios.
. // Sin portfolio
. reg (exc_ran4) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     15.96
       Model |  .481094713         1  .481094713   Prob > F        =    0.0002
    Residual |  1.59773829        53  .030146005   R-squared       =    0.2314
-------------+----------------------------------   Adj R-squared   =    0.2169
       Total |    2.078833        54  .038496907   Root MSE        =    .17363

------------------------------------------------------------------------------
    exc_ran4 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |    .939386    .2351493     3.99   0.000     .4677363    1.411036
       _cons |   .0533866    .0262714     2.03   0.047     .0006928    .1060804
------------------------------------------------------------------------------
```

Table 15: Random 5 Portfolio Regression of Excess Portfolio Return on Excess Market Return

```
. // CAPM regressions for all of the portfolios.
. // Ran5 portfolio
. reg (exc_ran5) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =      1.34
       Model |  8.53275545         1  8.53275545   Prob > F        =    0.2515
    Residual |  336.456334        53  6.34823271   R-squared       =    0.0247
-------------+----------------------------------   Adj R-squared   =    0.0063
       Total |  344.989089        54  6.38868684   Root MSE        =    2.5196

------------------------------------------------------------------------------
    exc_ran5 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   3.956156    3.412363     1.16   0.252    -2.888177    10.80049
       _cons |   .2295965    .3812371     0.60   0.550    -.5350682    .9942612
------------------------------------------------------------------------------

.
```

Table 16: Summary Table of Regression Results, Post-Outlier

Portfolio	Return (G. Mean)	Alpha	Significant (Level)	Sharpe Ratio
Market	9.3%	-	-	0.50
Ethical	9.26%	0%	N	0.50
Sin	13.80%	3.5%	Y(0.05)	0.55
Random 1	10.48%	0.5%	N	0.45
Random 2	24.21%	10.54%	N	0.23
Random 3	10.53%	2.85%	N	0.47
Random 4	18.18%	5.34%	Y (0.05)	0.51
Random 5	0.87%	22.95%	N	0.17

Information assembled from Appendix C, pp. C-16 to C-41

Appendix B

The Valdez Principles

1. Minimizing or eliminating the release of pollutants that harm air, water, the earth, or its inhabitants.
2. Minimizing practices that contribute to the Greenhouse Effect, ozone depletion, acid rain, or smog.
3. Conserving nonrenewable natural resources and protecting wildlife and wilderness.
4. Minimizing the creation of waste, especially hazardous waste.
5. Recycling when possible, and when not, disposing of waste responsibly.
6. Using safe and sustainable energy supplies.
7. Employing safe technologies and taking precautions to minimize health, environmental, and safety risks.
8. Marketing environmentally safe products.
9. Informing consumers of the environmental impact of the products they buy.
10. Compensating victims of damage.
11. Disclosing environmentally harmful operations.
12. Appointing a board member qualified to represent environmental interests.
13. Evaluating progress and working toward environmental audit procedures that will be available to the public.

Judd 1990, pp. 17-18.

Appendix C: Stata Do-Files and Output

Output 1: Standard Portfolios & Random Portfolios

```
  Regular Regression  Sunday April 14 09:47:07 2019   Page 1

                                          Statistics/Data Analysis

  1 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Random analysis\Sin Portfolio\04 Analy

  2 . // Analysis of portfolios
  3 . // Master data set
  4 . import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear

  5 . duplicates drop

    Duplicates in terms of all variables

    (638 observations deleted)

  6 . drop if A == "ident"
    (1 observation deleted)

  7 . drop if B == ""
    (3 observations deleted)

  8 . drop if B == "ticker"
    (1 observation deleted)

  9 . drop if C == ""
    (1 observation deleted)

 10 .
 11 . // Creates a numerical representation of date; days since 1/1/1960.
 12 . gen numdate = date(C, "MDY")

 13 .
 14 . // Destring and rename variables
 15 . encode(B), gen(ticker)

 16 . drop B

 17 . destring(I), gen(period) force
    I: all characters numeric; period generated as byte

 18 . drop I

 19 . destring(D), gen(price) force
    D: all characters numeric; price generated as double
    (44 missing values generated)

 20 . drop D

 21 . destring(E), gen(gics_code) force
    E: contains nonnumeric characters; gics_code generated as long
    (8276 missing values generated)

 22 . drop E

 23 . destring(F), gen(mkt_cap) force
    F: contains nonnumeric characters; mkt_cap generated as double
    (738 missing values generated)
```

```
   Regular Regression  Sunday April 14 09:47:07 2019   Page 2

24 . drop F

25 . destring(G), gen(eth_mkt_cap) force
   G: contains nonnumeric characters; eth_mkt_cap generated as double
   (60 missing values generated)

26 . drop G

27 . destring(H), gen(sin_mkt_cap) force
   H: all characters numeric; sin_mkt_cap generated as double
   (51 missing values generated)

28 . drop H

29 . rename C date

30 . rename A id

31 .
32 . // Generate our random portfolios
33 . gen ran1 = mkt_cap if (gics_code == 40102010) | (gics_code == 40301020) | (gics_code == 45202030
   >
   (53,554 missing values generated)

34 . gen ran2 = mkt_cap if (gics_code == 15101030) | (gics_code == 25504040) | (gics_code == 40101010
   >
   (54,014 missing values generated)

35 . gen ran3 = mkt_cap if (gics_code == 10101020) | (gics_code == 15105010) | (gics_code == 25401030
   >
   (53,358 missing values generated)

36 . gen ran4 = mkt_cap if (gics_code == 10102050) | (gics_code == 25102020) | (gics_code == 30301010
   >
   (54,294 missing values generated)

37 . gen ran5 = mkt_cap if (gics_code == 15101030) | (gics_code == 15102010) | (gics_code == 25201030
   >
   (54,653 missing values generated)

38 . duplicates drop

   Duplicates in terms of all variables

   (0 observations are duplicates)

39 . sort id numdate period

40 .
41 . // generates the groups used in calculating the returns
42 . egen period_group = group(period numdate)

43 . bysort period_group: egen total_cap = total(mkt_cap)

44 . bysort period_group: egen eth_cap = total(eth_mkt_cap)
```

```
  Regular Regression  Sunday April 14 09:47:07 2019   Page 3
45 . bysort period_group: egen sin_cap = total(sin_mkt_cap)

46 . bysort period_group: egen ran1_cap = total(ran1)

47 . bysort period_group: egen ran2_cap = total(ran2)

48 . bysort period_group: egen ran3_cap = total(ran3)

49 . bysort period_group: egen ran4_cap = total(ran4)

50 . bysort period_group: egen ran5_cap = total(ran5)

51 .
52 . // generates the return for each period
53 . gen tot_ret = total_cap/total_cap[_n-1] - 1
   (1 missing value generated)

54 . gen eth_ret = eth_cap/eth_cap[_n-1] - 1
   (1 missing value generated)

55 . gen sin_ret = sin_cap/sin_cap[_n-1] - 1
   (1 missing value generated)

56 . gen ran1_ret = ran1_cap/ran1_cap[_n-1] - 1
   (1 missing value generated)

57 . gen ran2_ret = ran2_cap/ran2_cap[_n-1] - 1
   (1 missing value generated)

58 . gen ran3_ret = ran3_cap/ran3_cap[_n-1] - 1
   (1 missing value generated)

59 . gen ran4_ret = ran4_cap/ran4_cap[_n-1] - 1
   (1 missing value generated)

60 . gen ran5_ret = ran5_cap/ran5_cap[_n-1] - 1
   (1 missing value generated)

61 .
62 .
63 . drop if period_group >= 57
   (27,501 observations deleted)

64 . duplicates drop

   Duplicates in terms of all variables

   (0 observations are duplicates)

65 . egen numSinCompInPeriod = count(sin_mkt_cap), by (numdate)

66 . egen avgComp = mean(numSinCompInPeriod)

67 . tab avgComp
```

avgComp	Freq.	Percent	Cum.
500.4863	28,030	100.00	100.00
Total	28,030	100.00	

```
Regular Regression  Sunday April 14 09:47:07 2019   Page 4

68 .
69 . egen numRan1CompInPeriod = count(ran1), by (numdate)

70 . egen avgCompRan1 = mean(numRan1CompInPeriod)

71 . tab avgCompRan1

avgCompRan1 |      Freq.     Percent        Cum.
------------+-----------------------------------
    17.8609 |     28,030      100.00      100.00
------------+-----------------------------------
      Total |     28,030      100.00

72 .
73 . egen numRan2CompInPeriod = count(ran2), by (numdate)

74 . egen avgCompRan2 = mean(numRan2CompInPeriod)

75 . tab avgCompRan2

avgCompRan2 |      Freq.     Percent        Cum.
------------+-----------------------------------
   12.97242 |     28,030      100.00      100.00
------------+-----------------------------------
      Total |     28,030      100.00

76 .
77 . egen numRan3CompInPeriod = count(ran3), by (numdate)

78 . egen avgCompRan3 = mean(numRan3CompInPeriod)

79 . tab avgCompRan3

avgCompRan3 |      Freq.     Percent        Cum.
------------+-----------------------------------
   19.61427 |     28,030      100.00      100.00
------------+-----------------------------------
      Total |     28,030      100.00

80 .
81 . egen numRan4CompInPeriod = count(ran4), by (numdate)

82 . egen avgCompRan4 = mean(numRan4CompInPeriod)

83 . tab avgCompRan4

avgCompRan4 |      Freq.     Percent        Cum.
------------+-----------------------------------
    11.3462 |     28,030      100.00      100.00
------------+-----------------------------------
      Total |     28,030      100.00

84 .
85 . egen numRan5CompInPeriod = count(ran5), by (numdate)
```

```
Regular Regression  Sunday April 14 09:47:07 2019   Page 5

. egen avgCompRan5 = mean(numRan5CompInPeriod)

. tab avgCompRan5
```

avgCompRan5	Freq.	Percent	Cum.
7.843561	28,030	100.00	100.00
Total	28,030	100.00	

```
.
. // clean up sheet
. drop if(tot_ret == 0)
(27,974 observations deleted)

. drop if(period_group>=57)
(0 observations deleted)

. sort numdate period

.
. //Regression
. use "final_tbill2.dta", clear

.
. /* File already saved; do not need to recreate variables.
> gen tbill2 = tbill/100
> drop tbill
> rename tbill2 tbill
>
> gen exc_mkt = tot_ret - tbill
> gen exc_eth = eth_ret - tbill
> gen exc_sin = sin_ret - tbill
> gen exc_ran1 = ran1_ret - tbill
> gen exc_ran2 = ran2_ret - tbill
> gen exc_ran3 = ran3_ret - tbill
> gen exc_ran4 = ran4_ret - tbill
> gen exc_ran5 = ran5_ret - tbill
> */
.
. gen pos_tot_ret = tot_ret + 1
(1 missing value generated)

. gen pos_eth_ret = eth_ret + 1
(1 missing value generated)

. gen pos_sin_ret = sin_ret + 1
(1 missing value generated)

. gen pos_ran1_ret = ran1_ret + 1
(1 missing value generated)

. gen pos_ran2_ret = ran2_ret + 1
(1 missing value generated)
```

```
   Regular Regression  Sunday April 14 09:47:08 2019   Page 6

. gen pos_ran3_ret = ran3_ret + 1
(1 missing value generated)

. gen pos_ran4_ret = ran4_ret + 1
(1 missing value generated)

. gen pos_ran5_ret = ran5_ret + 1
(1 missing value generated)

.
.
. // Calculate the sharpe ratios for each portfolio
. egen mean_tot_ret = mean(exc_mkt)

. egen std_tot_ret = sd(exc_mkt)

. gen tot_sharpe = mean_tot_ret / std_tot_ret

.
. egen mean_eth_ret = mean(exc_eth)

. egen std_eth_ret = sd(exc_eth)

. gen eth_sharpe = mean_eth_ret / std_eth_ret

.
. egen mean_sin_ret = mean(exc_sin)

. egen std_sin_ret = sd(exc_sin)

. gen sin_sharpe = mean_sin_ret / std_sin_ret

.
. egen mean_ran1_ret = mean(exc_ran1)

. egen std_ran1_ret = sd(exc_ran1)

. gen ran1_sharpe = mean_ran1_ret / std_ran1_ret

.
. egen mean_ran2_ret = mean(exc_ran2)

. egen std_ran2_ret = sd(exc_ran2)

. gen ran2_sharpe = mean_ran2_ret / std_ran2_ret

.
. egen mean_ran3_ret = mean(exc_ran3)

. egen std_ran3_ret = sd(exc_ran3)

. gen ran3_sharpe = mean_ran3_ret / std_ran3_ret

.
. egen mean_ran4_ret = mean(exc_ran4)
```

```
    Regular Regression  Sunday April 14 09:47:08 2019   Page 7

135 . egen std_ran4_ret = sd(exc_ran4)

136 . gen ran4_sharpe = mean_ran4_ret / std_ran4_ret

137 .
138 . egen mean_ran5_ret = mean(exc_ran5)

139 . egen std_ran5_ret = sd(exc_ran5)

140 . gen ran5_sharpe = mean_ran5_ret / std_ran5_ret

141 .
142 . // Quick access to the sharpe ratios as output
143 . tab tot_sharpe
```

tot_sharpe	Freq.	Percent	Cum.
.5018463	56	100.00	100.00
Total	56	100.00	

```
144 . tab eth_sharpe
```

eth_sharpe	Freq.	Percent	Cum.
.4960029	56	100.00	100.00
Total	56	100.00	

```
145 . tab sin_sharpe
```

sin_sharpe	Freq.	Percent	Cum.
.440334	56	100.00	100.00
Total	56	100.00	

```
146 . tab ran1_sharpe
```

ran1_sharpe	Freq.	Percent	Cum.
.4869031	56	100.00	100.00
Total	56	100.00	

```
147 . tab ran2_sharpe
```

ran2_sharpe	Freq.	Percent	Cum.
.3041859	56	100.00	100.00
Total	56	100.00	

```
148 . tab ran3_sharpe
```

ran3_sharpe	Freq.	Percent	Cum.
.3882067	56	100.00	100.00
Total	56	100.00	

Regular Regression Sunday April 14 09:47:08 2019 Page 8

149 . tab ran4_sharpe

ran4_sharpe	Freq.	Percent	Cum.
.5793529	56	100.00	100.00
Total	56	100.00	

150 . tab ran5_sharpe

ran5_sharpe	Freq.	Percent	Cum.
.2538594	56	100.00	100.00
Total	56	100.00	

151 .
152 . // Summary statistics of the returns
153 . sum tot_ret

Variable	Obs	Mean	Std. Dev.	Min	Max
tot_ret	55	.0506925	.100479	-.3497163	.2075088

154 . sum eth_ret

Variable	Obs	Mean	Std. Dev.	Min	Max
eth_ret	55	.0506187	.1015131	-.35101	.2108441

155 . sum sin_ret

Variable	Obs	Mean	Std. Dev.	Min	Max
sin_ret	55	.0581637	.1314891	-.3232218	.3837237

156 . sum ran1_ret

Variable	Obs	Mean	Std. Dev.	Min	Max
ran1_ret	55	.0742142	.1518719	-.4863122	.4218298

157 . sum ran2_ret

Variable	Obs	Mean	Std. Dev.	Min	Max
ran2_ret	55	.1292894	.4241733	-.3281597	2.39127

158 . sum ran3_ret

Variable	Obs	Mean	Std. Dev.	Min	Max
ran3_ret	55	.0552221	.1415708	-.5002974	.4837622

159 . sum ran4_ret

Variable	Obs	Mean	Std. Dev.	Min	Max
ran4_ret	55	.0876777	.1508529	-.3244707	.6422592

```
Regular Regression  Sunday April 14 09:47:08 2019   Page 9

160 . sum ran5_ret

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
    ran5_ret |         55    .1546319    .6080618  -.3891854   4.349576

161 .
162 . // Mean, Geometric mean of the returns. Must use positive values for geom. mean
163 . // SQUARE the biannual geometric mean to get the annualized geometric mean
164 . ameans(pos_tot_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+---------------------------------------------------------------
 pos_tot_ret | Arithmetic           55    1.050693       1.023529   1.077856
             |  Geometric           55    1.045468       1.016534   1.075226
             |   Harmonic           55    1.039571       1.008036   1.073142
-----------------------------------------------------------------------------

165 . ameans(pos_eth_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+---------------------------------------------------------------
 pos_eth_ret | Arithmetic           55    1.050619       1.023176   1.078062
             |  Geometric           55    1.045292       1.016092   1.075331
             |   Harmonic           55    1.039288         1.0075   1.073147
-----------------------------------------------------------------------------

166 . ameans(pos_sin_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+---------------------------------------------------------------
 pos_sin_ret | Arithmetic           55    1.058164       1.022617    1.09371
             |  Geometric           55    1.049585       1.012895   1.087604
             |   Harmonic           55    1.040256        1.00162   1.081991
-----------------------------------------------------------------------------

167 . ameans(pos_ran1_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+---------------------------------------------------------------
pos_ran1_ret | Arithmetic           55    1.074214       1.033157   1.115271
             |  Geometric           55    1.062195        1.01777   1.108558
             |   Harmonic           55    1.047849       .9970541   1.104097
-----------------------------------------------------------------------------

168 . ameans(pos_ran2_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+---------------------------------------------------------------
pos_ran2_ret | Arithmetic           55    1.129289       1.014619    1.24396
             |  Geometric           55    1.086965       1.017606   1.161051
             |   Harmonic           55    1.061633       1.010917   1.117707
-----------------------------------------------------------------------------

169 . ameans(pos_ran3_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+---------------------------------------------------------------
pos_ran3_ret | Arithmetic           55    1.055222        1.01695   1.093494
             |  Geometric           55    1.044607       1.003079   1.087854
             |   Harmonic           55    1.031765       .9833743   1.085165
-----------------------------------------------------------------------------
```

```
Regular Regression  Sunday April 14 09:47:08 2019   Page 10

170 . ameans(pos_ran4_ret)
```

Variable	Type	Obs	Mean	[95% Conf.	Interval]
pos_ran4_ret	Arithmetic	55	1.087678	1.046896	1.128459
	Geometric	55	1.0773	1.036949	1.119221
	Harmonic	55	1.066494	1.02507	1.111406

```
171 . ameans(pos_ran5_ret)
```

Variable	Type	Obs	Mean	[95% Conf.	Interval]
pos_ran5_ret	Arithmetic	55	1.154632	.9902498	1.319014
	Geometric	55	1.092371	1.013146	1.17779
	Harmonic	55	1.060459	1.003407	1.124391

```
172 .
173 . // From the ameans:
174 .
175 . display  1.045292* 1.045292    // annualized geometric mean for the ethical portfolio
    1.0926354

176 . display  1.049585 *  1.049585  //ann. geom. mean for sin portfolio
    1.1016287

177 . display  1.062195 *  1.062195  // ran1
    1.1282582

178 . display  1.086965 * 1.086965  // ran 2
    1.1814929

179 . display  1.044607 * 1.044607  // ran 3
    1.0912038

180 . display  1.0773 * 1.0773 // ran 4
    1.1605753

181 . display 1.092371 * 1.092371  //ran 5
    1.1932744

182 .
183 . // CAPM regressions for all of the portfolios.
184 . // Ethical portfolio
185 . reg (exc_eth) (exc_mkt)
```

Source	SS	df	MS			
				Number of obs	=	55
				F(1, 53)	=	51750.60
Model	.555704207	1	.555704207	Prob > F	=	0.0000
Residual	.00056912	53	.000010738	R-squared	=	0.9990
				Adj R-squared	=	0.9990
Total	.556273327	54	.010301358	Root MSE	=	.00328

exc_eth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
exc_mkt	1.009783	.0044388	227.49	0.000	1.00088	1.018686
_cons	-.000567	.0004953	-1.14	0.257	-.0015605	.0004264

```
  Regular Regression  Sunday April 14 09:47:09 2019   Page 11

186 . // Sin portfolio
187 . reg (exc_sin) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     19.00
       Model |  .246249868         1  .246249868   Prob > F        =    0.0001
    Residual |  .686987578        53   .01296203   R-squared       =    0.2639
-------------+----------------------------------   Adj R-squared   =    0.2500
       Total |  .933237446        54  .017282175   Root MSE        =    .11385

------------------------------------------------------------------------------
     exc_sin |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   .6721932   .1542207     4.36   0.000     .3628657    .9815208
       _cons |   .0239978   .0172083     1.39   0.169    -.0105177    .0585134
------------------------------------------------------------------------------

188 . // Random 1 portfolio
189 . reg (exc_ran1) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =    125.32
       Model |  .875104603         1  .875104603   Prob > F        =    0.0000
    Residual |  .370096129        53  .006982946   R-squared       =    0.7028
-------------+----------------------------------   Adj R-squared   =    0.6972
       Total |  1.24520073        54  .023059273   Root MSE        =    .08356

------------------------------------------------------------------------------
    exc_ran1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   1.267174   .1131945    11.19   0.000     1.040134    1.494213
       _cons |   .0100519   .0126305     0.80   0.430    -.0152818    .0353855
------------------------------------------------------------------------------

190 . // Random 2 portfolio
191 . reg (exc_ran2) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     11.35
       Model |  1.71321486         1  1.71321486   Prob > F        =    0.0014
    Residual |  8.00040784        53  .150951091   R-squared       =    0.1764
-------------+----------------------------------   Adj R-squared   =    0.1608
       Total |   9.7136227        54  .179881902   Root MSE        =    .38852

------------------------------------------------------------------------------
    exc_ran2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   1.773014    .526289     3.37   0.001     .7174115    2.828616
       _cons |   .0396247   .0587246     0.67   0.503     -.078162    .1574114
------------------------------------------------------------------------------

192 . // Random 3 portfolio
193 . reg (exc_ran3) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     72.69
       Model |  .625626615         1  .625626615   Prob > F        =    0.0000
    Residual |  .456134521        53  .008606312   R-squared       =    0.5783
-------------+----------------------------------   Adj R-squared   =    0.5704
       Total |  1.08176114        54  .020032614   Root MSE        =    .09277
```

```
Regular Regression  Sunday April 14 09:47:09 2019   Page 12

    exc_ran3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |    1.07143   .1256651     8.53   0.000     .8193776    1.323482
       _cons |   .0009283    .014022     0.07   0.947    -.0271963     .029053
------------------------------------------------------------------------------

194 . // Random 4 portfolio
195 . reg (exc_ran4) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     26.16
       Model |  .406173416         1  .406173416   Prob > F        =    0.0000
    Residual |  .822795983        53  .015524453   R-squared       =    0.3305
-------------+----------------------------------   Adj R-squared   =    0.3179
       Total |   1.2289694        54  .022758693   Root MSE        =     .1246

------------------------------------------------------------------------------
    exc_ran4 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   .8633003   .1687774     5.12   0.000     .5247757    1.201825
       _cons |    .043877   .0188326     2.33   0.024     .0061036    .0816504
------------------------------------------------------------------------------

196 . // Random 5 portfolio
197 . reg (exc_ran5) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =      0.22
       Model |  .082190809         1  .082190809   Prob > F        =    0.6416
    Residual |  19.8819398        53  .375130939   R-squared       =    0.0041
-------------+----------------------------------   Adj R-squared   =   -0.0147
       Total |  19.9641306        54  .369706122   Root MSE        =    .61248

------------------------------------------------------------------------------
    exc_ran5 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |    .388345   .8296551     0.47   0.642    -1.275732    2.052422
       _cons |   .1347765    .092575     1.46   0.151    -.0509054    .3204584
------------------------------------------------------------------------------

198 .
199 . //save final_tbill2.dta, replace
200 .
    end of do-file

201 .
```

Output 2: Portfolio Random 1 Generation

```
Ran1 Gen   Sunday April 14 20:50:25 2019   Page 1

                                                   ___  ____  ____  ____  ____(R)
                                                  /__    /   ____/   /   ____/
                                                 ___/   /   /___/   /   /___/
                                                   Statistics/Data Analysis

  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   15.1   Copyright 1985-2017 StataCorp LLC
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Notes:
      1.  Unicode is supported; see help unicode_advice.
      2.  New update available; type -update all-

. doedit "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Random analysis\Ran1 Portfolio\ran

. do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Random analysis\Ran1 Portfolio\ran_gen

. // master data set
. import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear

. duplicates drop

Duplicates in terms of all variables

(638 observations deleted)

. drop if A == "ident"
(1 observation deleted)

. drop if B == ""
(3 observations deleted)

. drop if B == "ticker"
(1 observation deleted)

. drop if C == ""
(1 observation deleted)

.
. // Creates a numerical representation of date; days since 1/1/1960.
. gen numdate = date(C, "MDY")

.
. // Destring and rename variables
. encode(B), gen(ticker)

. drop B
```

```
   Ran1 Gen  Sunday April 14 20:50:26 2019   Page 2

17 . destring(I), gen(period) force
   I: all characters numeric; period generated as byte

18 . drop I

19 . destring(D), gen(price) force
   D: all characters numeric; price generated as double
   (44 missing values generated)

20 . drop D

21 . destring(E), gen(gics_code) force
   E: contains nonnumeric characters; gics_code generated as long
   (8276 missing values generated)

22 . drop E

23 . destring(F), gen(mkt_cap) force
   F: contains nonnumeric characters; mkt_cap generated as double
   (738 missing values generated)

24 . drop F

25 . destring(G), gen(eth_mkt_cap) force
   G: contains nonnumeric characters; eth_mkt_cap generated as double
   (60 missing values generated)

26 . drop G

27 . destring(H), gen(sin_mkt_cap) force
   H: all characters numeric; sin_mkt_cap generated as double
   (51 missing values generated)

28 . drop H

29 . rename C date

30 . rename A id

31 .
32 . duplicates drop gics_code, force

   Duplicates in terms of gics_code

   (55,393 observations deleted)

33 . sort gics_code

34 .
35 . set seed 127127127

36 .
37 . sample 5, count
   (133 observations deleted)

38 . sort gics_code

39 . save var1.dta, replace
   file var1.dta saved

40 .
   end of do-file

41 .
```

Resulting Random Portfolio 1 GICS codes:

	id	date	price	gics_code
1	608	5/30/2008	25.42	40102010
2	284	12/29/2017	87.78	40301020
3	263	12/29/2017	169.23	45202030
4	300	12/29/2017	51.12	45301010
5	325	12/29/2017	130.59	60101040

The rest of the random portfolio code is not reproduced; the process is identical. The seeds used are as follows:

Table 17: Portfolio, Random Number Generator Seed, and corresponding GICS Codes

Portfolio	Seed	GICS Codes
Sin	--	10102050, 20101010, 25301010, 30201010, 30201020, 30203010
Random 1	127127127	40102010, 40301020, 45202030, 45301010, 60101040
Random 2	323232323	15101030, 25504040, 40101010, 40203020, 50101020
Random 3	989989989	10101020, 15105010, 25401030, 30202030, 40301030
Random 4	484484484	10102050, 25102020, 30301010, 35102010, 45101010
Random 5	147258369	15101030, 15102010, 25201030, 25302010, 25401025

Output 3: Outlier Analysis

Sin Portfolio

```
 Ran1 Outlier  Sunday April 14 21:44:02 2019   Page 1

                                                    Statistics/Data Analysis

 1 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\01 Locate Outliers\02
   > .do"

 2 . //master data set
 3 . import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear

 4 . duplicates drop

   Duplicates in terms of all variables

   (638 observations deleted)

 5 . drop if A == "ident"
   (1 observation deleted)

 6 . drop if B == ""
   (3 observations deleted)

 7 . drop if B == "ticker"
   (1 observation deleted)

 8 . drop if C == ""
   (1 observation deleted)

 9 .
10 . // Creates a numerical representation of date; days since 1/1/1960.
11 . gen numdate = date(C, "MDY")

12 .
13 . // Destring and rename variables
14 . encode(B), gen(ticker)

15 . drop B

16 . destring(I), gen(period) force
   I: all characters numeric; period generated as byte

17 . drop I

18 . destring(D), gen(price) force
   D: all characters numeric; price generated as double
   (44 missing values generated)

19 . drop D

20 . destring(E), gen(gics_code) force
   E: contains nonnumeric characters; gics_code generated as long
   (8276 missing values generated)

21 . drop E

22 . destring(F), gen(mkt_cap) force
   F: contains nonnumeric characters; mkt_cap generated as double
   (738 missing values generated)
```

```
   Ran1 Outlier  Sunday April 14 21:44:02 2019   Page 2

23 . drop F

24 . destring(G), gen(eth_mkt_cap) force
   G: contains nonnumeric characters; eth_mkt_cap generated as double
   (60 missing values generated)

25 . drop G

26 . destring(H), gen(sin_mkt_cap) force
   H: all characters numeric; sin_mkt_cap generated as double
   (51 missing values generated)

27 . drop H

28 . encode C, gen(date)

29 . drop C

30 . rename A id

31 .
32 . // We are only looking at the sin portfolio right now; remove the other portfolios.
33 . drop if sin_mkt_cap == 0
   (53,554 observations deleted)

34 . drop if sin_mkt_cap == .
   (51 observations deleted)

35 . drop period

36 . duplicates drop

   Duplicates in terms of all variables

   (937 observations deleted)

37 . sort ticker numdate

38 . bysort ticker : gen ret = sin_mkt_cap/sin_mkt_cap[_n-1] - 1
   (34 missing values generated)

39 .
40 . // generates the mean return by date; compare to see if one return was high/low during a time pe
41 . egen mean_ret = mean(ret), by (numdate)
   (13 missing values generated)

42 . egen med_ret = median(ret), by (numdate)
   (13 missing values generated)

43 . egen stdDevRet = sd(ret), by (numdate)
   (13 missing values generated)

44 . // flags as an outlier if its return was > 3 times the std deviation of the return of the entire
45 . gen outlier = 1 if(ret > 3 * stdDevRet)
   (949 missing values generated)
```

```
Ranl Outlier  Sunday April 14 21:44:02 2019   Page 3

46 .
47 . // generates total return of the portfolio for each time period
48 . egen tot_ret = total(mkt_cap), by (numdate)

49 .
50 . // used for counting later, 1 if is unique
51 . by ticker, sort: gen nvals = _n == 1

52 . quietly tab nvals

53 . // 34 unique values
54 .
55 . sort ticker numdate

56 . bysort ticker: gen size_ret = sin_mkt_cap - sin_mkt_cap[_n-1]
   (34 missing values generated)

57 . // It's an outlier if it accounts for more than 1/20th of the total return of the portfolio, i.e
> for >= 5% of the return of the portfolio.
58 . gen size_outlier = 1 if(abs(size_ret) > 1/20 * abs(tot_ret))
   (922 missing values generated)

59 .
60 . // if no graph shows up, they are not a CONSISTENT outlier, e.g. they were tagged only in one ye
61 . // twoway (line size_ret numdate, sort) if(size_outlier == 1), by (ticker)
62 .
63 . //GD is duplicated twice; see correction above.
64 . duplicates list (numdate ticker)

   Duplicates in terms of numdate ticker
```

group:	obs:	numdate	ticker
1	256	19145	GD
1	257	19145	GD
2	264	20453	GD
2	265	20453	GD

```
65 . // duplicate "GD;" (630) need to track prior steps and determine what it should actually be.
66 . drop if (ticker == 630)
   (1 observation deleted)

67 .
68 .
69 . duplicates tag (ticker numdate), generate(dup)

   Duplicates in terms of ticker numdate

70 . drop if dup == 1
   (4 observations deleted)

71 . drop dup
```

```
   Ranl Outlier  Sunday April 14 21:44:03 2019   Page 4

72 . xtset ticker date
          panel variable:  ticker (unbalanced)
           time variable:  date, 1 to 56, but with gaps
                   delta:  1 unit

73 . tab size_outlier

   size_outlie |
             r |      Freq.     Percent        Cum.
   ------------+-----------------------------------
             1 |         66      100.00      100.00
   ------------+-----------------------------------
         Total |         66      100.00

74 .
75 . sort ticker size_outlier

76 . //counts the number of times it is flagged as an outlier
77 . quietly by ticker: count if (size_outlier == 1)

78 . //computes the avg-return for each ticker; used for scatter plot outlier identification
79 . egen avg_ret = mean(ret), by (ticker)
   (2 missing values generated)

80 . // totals the number of times a company was an outlier across all time periods.
81 . egen numOutlier = total(size_outlier), by (ticker)

82 .
83 . //Generate graphs
84 . graph drop _all

85 . xtline ret if (numOutlier > 1 & sin_mkt_cap > 0), overlay name(first)

86 . xtline mkt_cap if (numOutlier > 1 & sin_mkt_cap > 0), overlay name(second)

87 . scatter avg_ret ticker if (numOutlier > 1 & sin_mkt_cap > 0), mlabel(ticker) name(third)

88 .
89 . //tab sin_ret if nvals == 1
90 .
91 . //number of sin companies in each period
92 . egen numSinCompInPeriod = count(sin_mkt_cap > 0), by (numdate)

93 . egen avgComp = mean(numSinCompInPeriod) //avg =~ 19

94 . tab avgComp

       avgComp |      Freq.     Percent        Cum.
   ------------+-----------------------------------
       18.9187 |        984      100.00      100.00
   ------------+-----------------------------------
         Total |        984      100.00

95 .
   end of do-file

96 .
```

The rest of the Stata files, for portfolios Ran1-Ran5, are omitted; the process is identical to that used in the Sin Portfolio documentation. The following figures show the outliers for each portfolio.

Figure 3: Scatterplot of Sin Portfolio Outliers

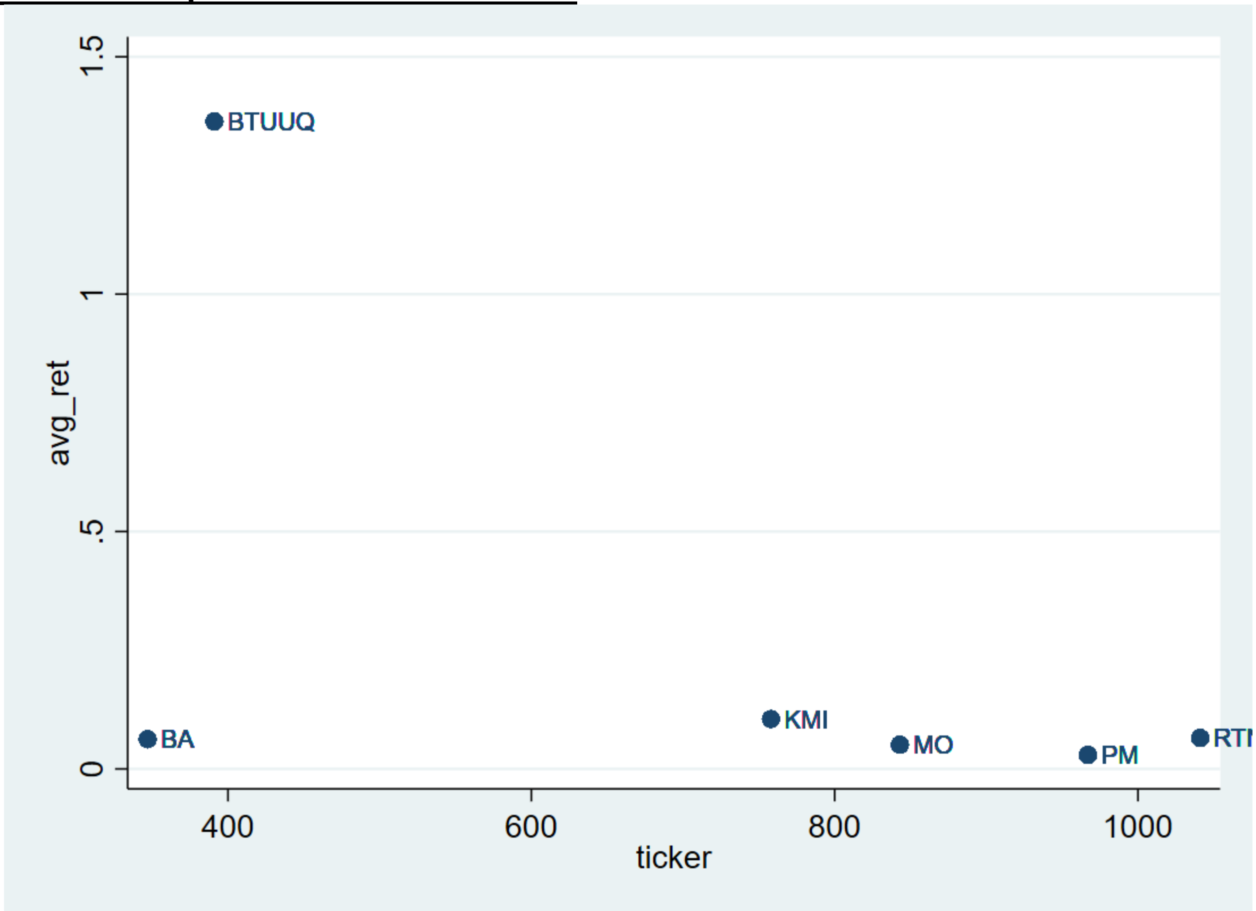


Figure 4: Scatterplot of Portfolio Random 1 Outliers

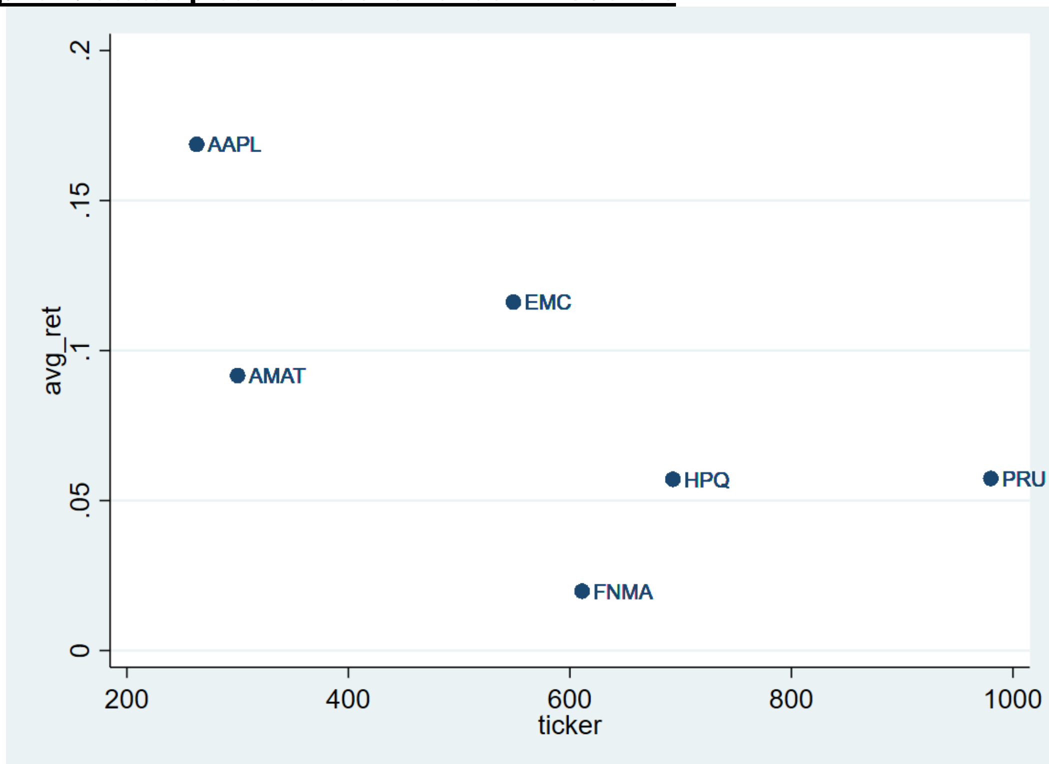


Figure 5: Scatterplot of Portfolio Random 2 Outliers

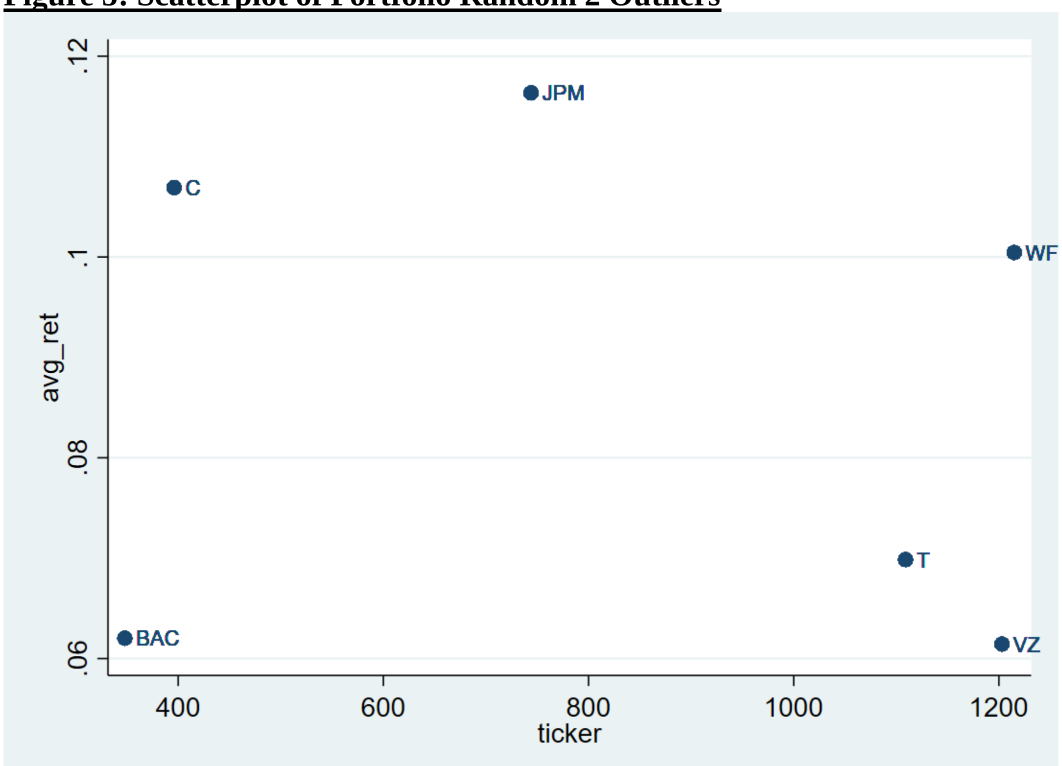


Figure 6: Scatterplot of Portfolio Random 3 Outliers

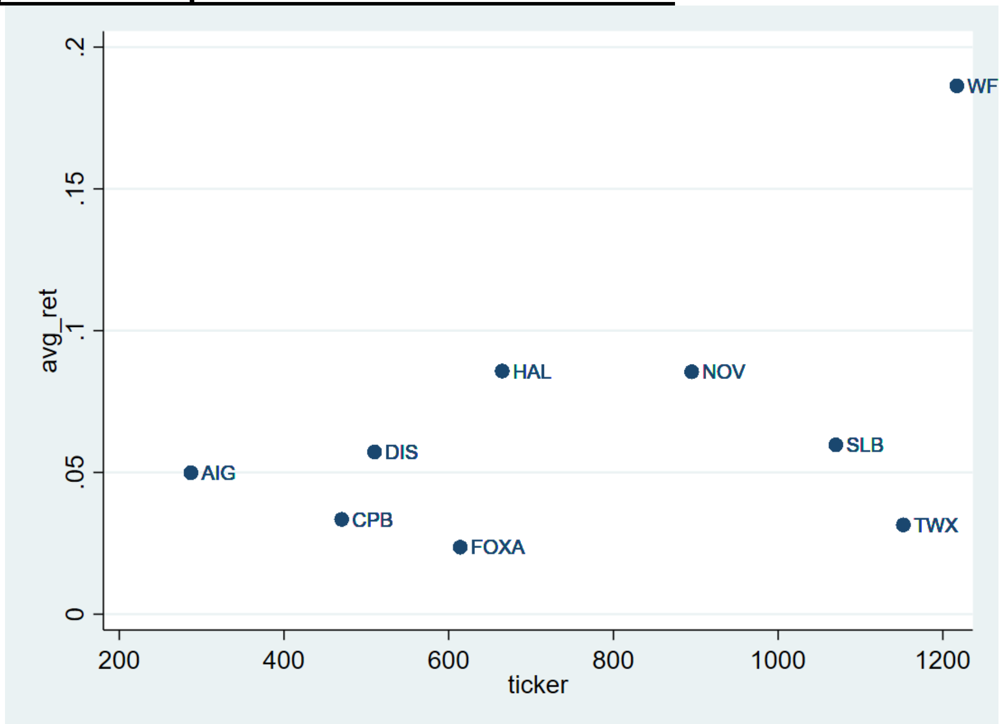


Figure 7: Scatterplot of Portfolio Random 4 Outliers

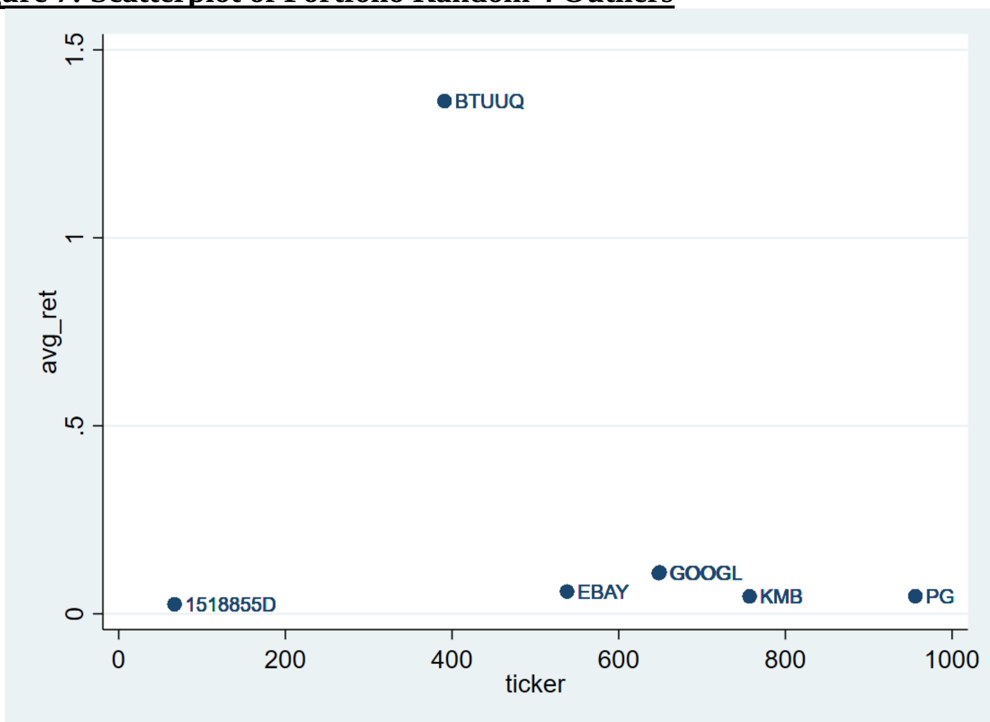
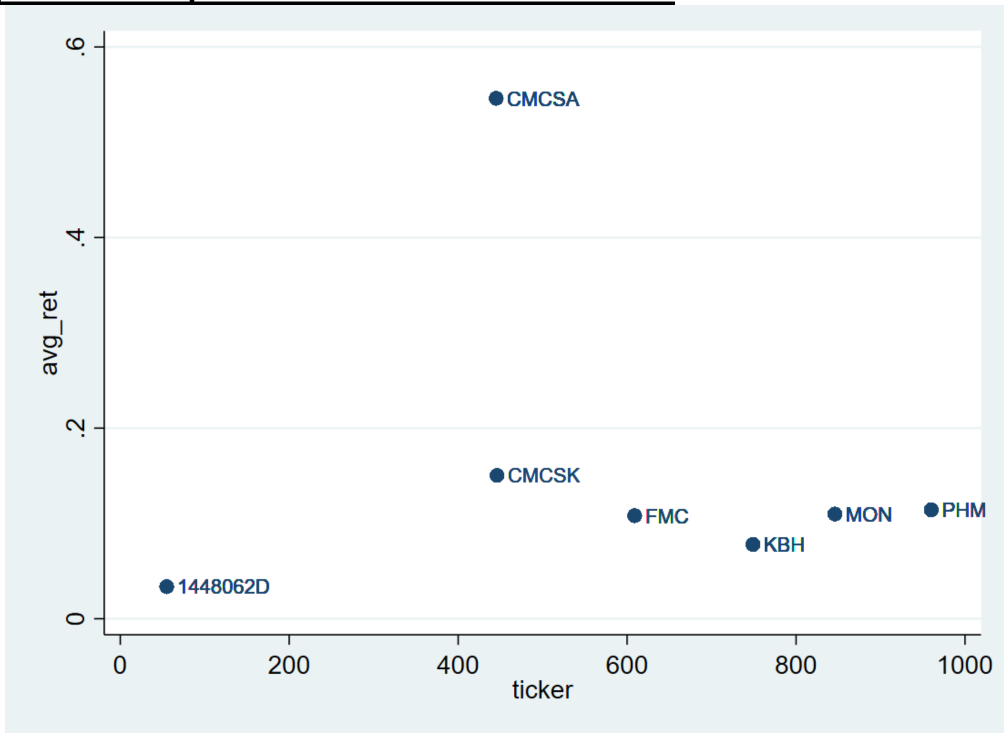


Figure 8: Scatterplot of Portfolio Random 5 Outliers



Output 4: Regression Analysis Post Outlier Removal

```
  Sin Post Outlier  Sunday April 14 22:08:23 2019   Page 1

                                                    ___  ____  ____  ____  ____(R)
                                                   /__    /   ____/   /   ____/
                                                  ___/   /   /___/   /   /___/
                                                    Statistics/Data Analysis

1 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\02 Remove Outliers an
  > an.do"

2 . // Analysis of random portfolio 1
3 . // Master data set
4 . /* VARIABLES ALREADY GENERATED. SKIP TO UNCOMMENTED SECTION.
  > import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear
  > duplicates drop
  > drop if A == "ident"
  > drop if B == ""
  > drop if B == "ticker"
  > drop if C == ""
  >
  > // Creates a numerical representation of date; days since 1/1/1960.
  > gen numdate = date(C, "MDY")
  >
  > // Destring and rename variables
  >
  >
  > encode(B), gen(ticker)
  > drop B
  > destring(I), gen(period) force
  > drop I
  > destring(D), gen(price) force
  > drop D
  > destring(E), gen(gics_code) force
  > drop E
  > destring(F), gen(mkt_cap) force
  > drop F
  > destring(G), gen(eth_mkt_cap) force
  > drop G
  > destring(H), gen(sin_mkt_cap) force
  > drop H
  > rename C date
  > rename A id
  >
  > //drop the outliers
  > drop if (id == "347") // BA
  > drop if (id == "756") // KMI
  > drop if (id == "841") // MO
  > drop if (id == "391") // BTUUQ
  > drop if (id == "964") // PM
  > drop if (id == "1038") // RTN
  > // Only re-doing sin portfolio analysis
  > drop if sin_mkt_cap == 0
  > drop if sin_mkt_cap == .
  > duplicates drop
  >
  > sort id numdate period
  >
  > // generates the groups used in calculating the returns
  > egen period_group = group(period numdate)
  > bysort period_group: egen sin_cap = total(sin_mkt_cap)
  > // generates the return for each period
  > gen sin_ret = sin_cap/sin_cap[_n-1] - 1
  >
  > drop if period_group >= 57
  > duplicates drop
  > egen numSinCompInPeriod = count(sin_mkt_cap), by (numdate)
  > egen avgComp = mean(numSinCompInPeriod) //avg =~ 19
  > tab avgComp
  >
  >
  > // clean up sheet
  > drop if(sin_ret == 0)
  > drop if(period_group>=57)
```

```
Sin Post Outlier  Sunday April 14 22:08:23 2019   Page 2

> sort numdate period
> save "sin_outl.dta", replace
> */
 5 .
 6 . // Regression
 7 .  use "01 sin_outl.dta", clear

 8 .
 9 . gen tbill2 = tbill/100
   (1 missing value generated)

10 . drop tbill

11 . rename tbill2 tbill

12 .
13 . //gen exc_sin = sin_ret - tbill
14 . gen exc_mkt = tot_ret - tbill
   (1 missing value generated)

15 .
16 . gen pos_sin_ret = sin_ret + 1
   (1 missing value generated)

17 .
18 . // Calculate the sharpe ratios for each portfolio
19 .
20 . egen mean_sin_ret = mean(exc_sin)

21 . egen std_sin_ret = sd(exc_sin)

22 . gen sin_sharpe = mean_sin_ret / std_sin_ret

23 .
24 . // Quick access to the sharpe ratios as output
25 . tab sin_sharpe
```

sin_sharpe	Freq.	Percent	Cum.
.5526364	56	100.00	100.00
Total	56	100.00	

```
26 .
27 . // Summary statistics of the returns
28 . sum sin_ret
```

Variable	Obs	Mean	Std. Dev.	Min	Max
sin_ret	55	.0750852	.1358626	-.3134014	.6454702

```
29 .
30 . // Mean, Geometric mean of the returns. Must use positive values for geom. mean
31 . // SQUARE the biannual geometric mean to get the annualized geometric mean
32 . ameans(pos_sin_ret)
```

Variable	Type	Obs	Mean	[95% Conf.	Interval]
pos_sin_ret	Arithmetic	55	1.075085	1.038356	1.111814
	Geometric	55	1.066785	1.031024	1.103787
	Harmonic	55	1.058347	1.022166	1.097183

```
   Sin Post Outlier  Sunday April 14 22:08:23 2019   Page 3

33 .
34 . // From the ameans:
35 . display   1.066785  *  1.066785   //ann. geom. mean for sin portfolio
   1.1380302

36 .
37 . // CAPM regressions for all of the portfolios.
38 . // Sin portfolio
39 . reg (exc_sin) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     27.80
       Model |  .342977171         1  .342977171   Prob > F        =    0.0000
    Residual |  .653785806        53  .012335581   R-squared       =    0.3441
-------------+----------------------------------   Adj R-squared   =    0.3317
       Total |  .996762977        54  .018458574   Root MSE        =    .11107

------------------------------------------------------------------------------
     exc_sin |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   .7931597   .1504208     5.27   0.000     .4914538    1.094866
       _cons |   .0348752   .0168056     2.08   0.043     .0011675    .0685829
------------------------------------------------------------------------------

40 .
   end of do-file

41 .
```

Random 1 Portfolio Post Outlier

```
Ran1 Post Outlier  Sunday April 14 22:20:30 2019   Page 1

                                                      ___  ____  ____  ____  ____(R)
                                                     /__    /   ____/   /   ____/
                                                    ___/   /   /___/   /   /___/
                                                      Statistics/Data Analysis

  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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                                      979-696-4601 (fax)

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         Licensed to:  test1

Notes:
      1.  Unicode is supported; see help unicode_advice.
      2.  New update available; type -update all-

1 . doedit "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\02 Remove Outlier
  > 1_clean.do"

2 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\02 Remove Outliers an
  > ean.do"

3 . // Analysis of random portfolio 1
4 . // Master data set
5 . /* VARIABLES ALREADY GENERATED. SKIP TO UNCOMMENTED SECTION.
  > import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear
  > duplicates drop
  > drop if A == "ident"
  > drop if B == ""
  > drop if B == "ticker"
  > drop if C == ""
  >
  > // Creates a numerical representation of date; days since 1/1/1960.
  > gen numdate = date(C, "MDY")
  >
  > // Destring and rename variables
  >
  >
  > encode(B), gen(ticker)
  > drop B
  > destring(I), gen(period) force
  > drop I
  > destring(D), gen(price) force
  > drop D
  > destring(E), gen(gics_code) force
  > drop E
  > destring(F), gen(mkt_cap) force
  > drop F
  > destring(G), gen(eth_mkt_cap) force
  > drop G
  > destring(H), gen(sin_mkt_cap) force
  > drop H
  > rename C date
  > rename A id
  >
  > //drop the outliers
  > drop if (id == "263") // AAPL
  > drop if (id == "548") // EMC
  > drop if (id == "691") // HPQ
  > drop if (id == "300") // AMAT
  > drop if (id == "609") // FNMA
  > drop if (id == "977") // PRU
  > gen ran1 = mkt_cap if (gics_code == 40102010) | (gics_code == 40301020) | (gics_code == 45202030
```

```
Ranl Post Outlier  Sunday April 14 22:20:30 2019   Page 2

    > | (gics_code == 60101040) ///
    > // Only re-doing ranl portfolio analysis
    > drop if ranl == 0
    > drop if ranl == .
    > duplicates drop
    >
    > sort id numdate period
    >
    > // generates the groups used in calculating the returns
    > egen period_group = group(period numdate)
    > bysort period_group: egen ranl_cap = total(ranl)
    > // generates the return for each period
    > gen ranl_ret = ranl_cap/ranl_cap[_n-1] - 1
    >
    > drop if period_group >= 57
    > duplicates drop
    > egen numRanlCompInPeriod = count(ranl), by (numdate)
    > egen avgComp = mean(numRanlCompInPeriod) //avg =~ 19
    > tab avgComp
    >
    > // clean up sheet
    > drop if(ranl_ret == 0)
    > drop if(period_group>=57)
    > sort numdate period
    > save "02 ranl_outl.dta", replace
    > */
  6 .
  7 . // Regression
  8 .  use "02 ranl_outl.dta", clear

  9 .
 10 . gen tbill2 = tbill/100
    (1 missing value generated)

 11 . drop tbill

 12 . rename tbill2 tbill

 13 .
 14 . gen exc_ranl = ranl_ret - tbill
    (1 missing value generated)

 15 . gen exc_mkt = tot_ret - tbill
    (1 missing value generated)

 16 .
 17 . gen pos_ranl_ret = ranl_ret + 1
    (1 missing value generated)

 18 .
 19 . // Calculate the sharpe ratios for each portfolio
 20 .
 21 . egen mean_ranl_ret = mean(exc_ranl)

 22 . egen std_ranl_ret = sd(exc_ranl)
```

```
   Ranl Post Outlier  Sunday April 14 22:20:30 2019   Page 3

23 . gen ranl_sharpe = mean_ranl_ret / std_ranl_ret

24 .
25 . // Quick access to the sharpe ratios as output
26 . tab ranl_sharpe

   ranl_sharpe |      Freq.     Percent        Cum.
   ------------+-----------------------------------
      .4467936 |         56      100.00      100.00
   ------------+-----------------------------------
         Total |         56      100.00

27 .
28 . // Summary statistics of the returns
29 . sum ranl_ret

      Variable |        Obs        Mean    Std. Dev.       Min        Max
   -------------+---------------------------------------------------------
      ranl_ret |         55    .0614704    .1375751  -.5007366   .3614745

30 .
31 . // Mean, Geometric mean of the returns. Must use positive values for geom. mean
32 . // SQUARE the biannual geometric mean to get the annualized geometric mean
33 . ameans(pos_ranl_ret)

      Variable |    Type             Obs        Mean       [95% Conf. Interval]
   -------------+---------------------------------------------------------------
   pos_ranl_ret |   Arithmetic         55     1.06147       1.024279   1.098662
               |    Geometric         55    1.051097       1.009575   1.094327
               |     Harmonic         55     1.03816       .9889516   1.092522
   -----------------------------------------------------------------------------

34 .
35 . // From the ameans:
36 . display    1.051097    *    1.051097    //ann. geom. mean for sin portfolio
   1.1048049

37 .
38 . // CAPM regressions for all of the portfolios.
39 . // Sin portfolio
40 . reg (exc_ranl) (exc_mkt)

         Source |       SS           df       MS      Number of obs   =        55
   -------------+----------------------------------   F(1, 53)        =     96.38
          Model |  .659431821         1  .659431821   Prob > F        =    0.0000
       Residual |  .362618706        53  .006841862   R-squared       =    0.6452
   -------------+----------------------------------   Adj R-squared   =    0.6385
          Total |  1.02205053        54  .018926862   Root MSE        =    .08272

   ------------------------------------------------------------------------------
       exc_ranl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
   -------------+----------------------------------------------------------------
        exc_mkt |     1.0998   .1120253     9.82   0.000     .8751059    1.324494
          _cons |    .005719   .0125157     0.46   0.650    -.0193844    .0308223
   ------------------------------------------------------------------------------

41 .
   end of do-file

42 .
```

Random 2 Portfolio Post Outlier

```
Ran2 Post Outlier  Sunday April 14 22:21:28 2019   Page 1

                                          ___  ____  ____  ____  ____(R)
                                         /__    /   ____/   /   ____/
                                        ___/   /   /___/   /   /___/
                                          Statistics/Data Analysis

1 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\02 Remove Outliers an
  > ean.do"

2 . // Analysis of random portfolio 1
3 . // Master data set
4 . /* VARIABLES ALREADY GENERATED. GO TO UNCOMMENTED PART.
  > import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear
  > duplicates drop
  > drop if A == "ident"
  > drop if B == ""
  > drop if B == "ticker"
  > drop if C == ""
  >
  > // Creates a numerical representation of date; days since 1/1/1960.
  > gen numdate = date(C, "MDY")
  >
  > // Destring and rename variables
  >
  >
  > encode(B), gen(ticker)
  > drop B
  > destring(I), gen(period) force
  > drop I
  > destring(D), gen(price) force
  > drop D
  > destring(E), gen(gics_code) force
  > drop E
  > destring(F), gen(mkt_cap) force
  > drop F
  > destring(G), gen(eth_mkt_cap) force
  > drop G
  > destring(H), gen(sin_mkt_cap) force
  > drop H
  > rename C date
  > rename A id
  >
  > //drop the outliers
  > drop if (id == "348") // BAC
  > drop if (id == "396") // C
  > drop if (id == "742") // JPM
  > drop if (id == "1105") // T
  > drop if (id == "1201") // VZ
  > drop if (id == "1212") // WFC
  > gen ran2 = mkt_cap if (gics_code == 15101030) | (gics_code == 25504040) | (gics_code == 40101010
  >  | (gics_code == 50101020) ///
  >
  > // Only re-doing ran2 portfolio analysis
  > drop if ran2 == 0
  > drop if ran2 == .
  > duplicates drop
  >
  > sort id numdate period
  >
  > // generates the groups used in calculating the returns
  > egen period_group = group(period numdate)
  > bysort period_group: egen ran2_cap = total(ran2)
  > // generates the return for each period
  > gen ran2_ret = ran2_cap/ran2_cap[_n-1] - 1
  >
  > drop if period_group >= 57
  > duplicates drop
  > egen numRan2CompInPeriod = count(ran2), by (numdate)
  > egen avgComp = mean(numRan2CompInPeriod) //avg =~ 19
  > tab avgComp
  >
  > // clean up sheet
```

```
Ran2 Post Outlier  Sunday April 14 22:21:28 2019   Page 2

> drop if(ran2_ret == 0)
> drop if(period_group>=57)
> sort numdate period
> save "02 ran2_outl.dta", replace
> */
 5 .
 6 . // Regression
 7 . use "02 ran2_outl.dta", clear

 8 . /*
> gen tbill2 = tbill/100
> drop tbill
> rename tbill2 tbill
>
> gen exc_ran2 = ran2_ret - tbill
> gen exc_mkt = tot_ret - tbill
>
> gen pos_ran2_ret = ran2_ret + 1
>
> // Calculate the sharpe ratios for each portfolio
>
> egen mean_ran2_ret = mean(exc_ran2)
> egen std_ran2_ret = sd(exc_ran2)
> gen ran2_sharpe = mean_ran2_ret / std_ran2_ret
> */
 9 . // Quick access to the sharpe ratios as output
10 . tab ran2_sharpe
```

ran2_sharpe	Freq.	Percent	Cum.
.2298214	56	100.00	100.00
Total	56	100.00	

```
11 .
12 . // Summary statistics of the returns
13 . sum ran2_ret
```

Variable	Obs	Mean	Std. Dev.	Min	Max
ran2_ret	55	.223382	.971969	-.41161	7.097242

```
14 .
15 . // Mean, Geometric mean of the returns. Must use positive values for geom. mean
16 . // SQUARE the biannual geometric mean to get the annualized geometric mean
17 . ameans(pos_ran2_ret)
```

Variable	Type	Obs	Mean	[95% Conf.	Interval]
pos_ran2_ret	Arithmetic	55	1.223382	.9606219	1.486142
	Geometric	55	1.114515	1.017594	1.220668
	Harmonic	55	1.070629	1.006315	1.143725

```
18 .
```

```
  Ran2 Post Outlier   Sunday April 14 22:21:28 2019    Page 3

19 . // From the ameans:
20 . display 1.114515 *  1.114515 //ann. geom. mean for sin portfolio
  1.2421437

21 .
22 . // CAPM regressions for all of the portfolios.
23 . // Ran2 portfolio
24 . reg (exc_ran2) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =      3.26
       Model |  2.9551886         1  2.9551886     Prob > F        =    0.0767
    Residual |  48.0598527        53  .906789674   R-squared       =    0.0579
-------------+----------------------------------   Adj R-squared   =    0.0402
       Total |  51.0150413        54  .944722988   Root MSE        =    .95226

------------------------------------------------------------------------------
    exc_ran2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   2.328206    1.28968     1.81   0.077    -.2585652    4.914977
       _cons |    .105363   .1440861     0.73   0.468    -.1836371     .394363
------------------------------------------------------------------------------

25 .
  end of do-file

26 .
```

Random 3 Portfolio Post Outlier

```
Ran3 Post Outlier  Sunday April 14 22:22:03 2019   Page 1

                                       ___  ____  ____  ____  ____(R)
                                      /__    /   ____/   /   ____/
                                     ___/   /   /___/   /   /___/
                                       Statistics/Data Analysis

1 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\02 Remove Outliers an
  > ean.do"

2 . // Analysis of random portfolio 1
3 . // Master data set
4 . /* VARIABLES ALREADY CREATED. SKIP TO UNCOMMENTED SECTION.
  > import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear
  > duplicates drop
  > drop if A == "ident"
  > drop if B == ""
  > drop if B == "ticker"
  > drop if C == ""
  >
  > // Creates a numerical representation of date; days since 1/1/1960.
  > gen numdate = date(C, "MDY")
  >
  > // Destring and rename variables
  >
  >
  > encode(B), gen(ticker)
  > drop B
  > destring(I), gen(period) force
  > drop I
  > destring(D), gen(price) force
  > drop D
  > destring(E), gen(gics_code) force
  > drop E
  > destring(F), gen(mkt_cap) force
  > drop F
  > destring(G), gen(eth_mkt_cap) force
  > drop G
  > destring(H), gen(sin_mkt_cap) force
  > drop H
  > rename C date
  > rename A id
  >
  > //drop the outliers
  > drop if (id == "287") // AIG
  > drop if (id == "509") // DIS
  > drop if (id == "663") // HAL
  > drop if (id == "1067") // SLB
  > drop if (id == "1214") // WFT
  > drop if (id == "470") // CPB
  > drop if (id == "612") // FOXA
  > drop if (id == "893") // NOV
  > drop if (id == "1149") // TWX
  > gen ran3 = mkt_cap if (gics_code == 10101020) | (gics_code == 15105010) | (gics_code == 25401030
  >  | (gics_code == 40301030) ///
  >
  > // Only re-doing ran3 portfolio analysis
  > drop if ran3 == 0
  > drop if ran3 == .
  > duplicates drop
  >
  > sort id numdate period
  >
  > // generates the groups used in calculating the returns
  > egen period_group = group(period numdate)
  > bysort period_group: egen ran3_cap = total(ran3)
  > // generates the return for each period
  > gen ran3_ret = ran3_cap/ran3_cap[_n-1] - 1
  >
  > drop if period_group >= 57
  > duplicates drop
  > egen numRan3CompInPeriod = count(ran3), by (numdate)
  > egen avgComp = mean(numRan3CompInPeriod) //avg =~ 19
```

```
Ran3 Post Outlier   Sunday April 14 22:22:03 2019    Page 2

> tab avgComp
>
> // clean up sheet
> drop if(ran3_ret == 0)
> drop if(period_group>=57)
> sort numdate period
> save "02 ran3_outl.dta", replace
> */
 5 .
 6 . // Regression
 7 . use "02 ran3_outl.dta", clear

 8 .
 9 . gen tbill2 = tbill/100
   (1 missing value generated)

10 . drop tbill

11 . rename tbill2 tbill

12 .
13 . gen exc_ran3 = ran3_ret - tbill
   (1 missing value generated)

14 . gen exc_mkt = tot_ret - tbill
   (1 missing value generated)

15 .
16 . gen pos_ran3_ret = ran3_ret + 1
   (1 missing value generated)

17 .
18 . // Calculate the sharpe ratios for each portfolio
19 .
20 . egen mean_ran3_ret = mean(exc_ran3)

21 . egen std_ran3_ret = sd(exc_ran3)

22 . gen ran3_sharpe = mean_ran3_ret / std_ran3_ret

23 .
24 . // Quick access to the sharpe ratios as output
25 . tab ran3_sharpe
```

ran3_sharpe	Freq.	Percent	Cum.
.4691528	56	100.00	100.00
Total	56	100.00	

```
26 .
27 . // Summary statistics of the returns
28 . sum ran3_ret
```

Variable	Obs	Mean	Std. Dev.	Min	Max
ran3_ret	55	.0590055	.1257647	-.365367	.3931772

```
  Ran3 Post Outlier  Sunday April 14 22:22:03 2019   Page 3

29 .
30 . // Mean, Geometric mean of the returns. Must use positive values for geom. mean
31 . // SQUARE the biannual geometric mean to get the annualized geometric mean
32 . ameans(pos_ran3_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+---------------------------------------------------------------
pos_ran3_ret | Arithmetic           55    1.059005        1.025007   1.093004
             |  Geometric           55    1.051355        1.016822    1.08706
             |   Harmonic           55    1.043183        1.007016   1.082045
-----------------------------------------------------------------------------

33 .
34 . // From the ameans:
35 . display 1.051355 *  1.051355 //ann. geom. mean for sin portfolio
  1.1053473

36 .
37 . // CAPM regressions for all of the portfolios.
38 . // Ran3 portfolio
39 . reg (exc_ran3) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =     15.91
       Model |  .197196397         1  .197196397   Prob > F        =    0.0002
    Residual |  .656904237        53   .01239442   R-squared       =    0.2309
-------------+----------------------------------   Adj R-squared   =    0.2164
       Total |  .854100634        54  .015816678   Root MSE        =    .11133

------------------------------------------------------------------------------
    exc_ran3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     exc_mkt |   .6014206   .1507794     3.99   0.000     .2989955    .9038457
       _cons |   .0285168   .0168454     1.69   0.096    -.0052708    .0623045
------------------------------------------------------------------------------

40 .
  end of do-file

41 .
```

Random 4 Portfolio Post Outlier

```
 Ran4 Post Outlier  Sunday April 14 22:22:26 2019   Page 1

                                      ___  ____  ____  ____  ____(R)
                                     /__    /   ____/   /   ____/
                                    ___/   /   /___/   /   /___/
                                      Statistics/Data Analysis

1 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\02 Remove Outliers an
  > ean.do"

2 . // Analysis of random portfolio 1
3 . // Master data set
4 . /* VARIABLES CREATED. GO TO UNCOMMENTED SECTION.
  > import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear
  > duplicates drop
  > drop if A == "ident"
  > drop if B == ""
  > drop if B == "ticker"
  > drop if C == ""
  >
  > // Creates a numerical representation of date; days since 1/1/1960.
  > gen numdate = date(C, "MDY")
  >
  > // Destring and rename variables
  >
  >
  > encode(B), gen(ticker)
  > drop B
  > destring(I), gen(period) force
  > drop I
  > destring(D), gen(price) force
  > drop D
  > destring(E), gen(gics_code) force
  > drop E
  > destring(F), gen(mkt_cap) force
  > drop F
  > destring(G), gen(eth_mkt_cap) force
  > drop G
  > destring(H), gen(sin_mkt_cap) force
  > drop H
  > rename C date
  > rename A id
  >
  > //drop the outliers
  > drop if (id == "68") // 1518855D
  > drop if (id == "391") // BTUUQ
  > drop if (id == "646") // GOOG
  > drop if (id == "537") // EBAY
  > drop if (id == "647") // GOOGL
  > drop if (id == "755") // KMB
  > drop if (id == "954") // PG
  > gen ran4 = mkt_cap if (gics_code == 10102050) | (gics_code == 25102020) | (gics_code == 30301010
  >  | (gics_code == 45101010) ///
  >
  > // Only re-doing ran4 portfolio analysis
  > drop if ran4 == 0
  > drop if ran4 == .
  > duplicates drop
  >
  > sort id numdate period
  >
  > // generates the groups used in calculating the returns
  > egen period_group = group(period numdate)
  > bysort period_group: egen ran4_cap = total(ran4)
  > // generates the return for each period
  > gen ran4_ret = ran4_cap/ran4_cap[_n-1] - 1
  >
  > drop if period_group >= 57
  > duplicates drop
  > egen numRan4CompInPeriod = count(ran4), by (numdate)
  > egen avgComp = mean(numRan4CompInPeriod) //avg =~ 19
  > tab avgComp
  >
```

```
Ran4 Post Outlier  Sunday April 14 22:22:26 2019   Page 2

> // clean up sheet
> drop if(ran4_ret == 0)
> drop if(period_group>=57)
> sort numdate period
> save "02 ran4_outl.dta", replace
> */
 .
 . // Regression
 . use "02 ran4_outl.dta", clear

 .
 . gen tbill2 = tbill/100
 (1 missing value generated)

 . drop tbill

 . rename tbill2 tbill

 .
 . gen exc_ran4 = ran4_ret - tbill
 (1 missing value generated)

 . gen exc_mkt = tot_ret - tbill
 (1 missing value generated)

 .
 . gen pos_ran4_ret = ran4_ret + 1
 (1 missing value generated)

 .
 . // Calculate the sharpe ratios for each portfolio
 .
 . egen mean_ran4_ret = mean(exc_ran4)

 . egen std_ran4_ret = sd(exc_ran4)

 . gen ran4_sharpe = mean_ran4_ret / std_ran4_ret

 .
 . // Quick access to the sharpe ratios as output
 . tab ran4_sharpe
```

ran4_sharpe	Freq.	Percent	Cum.
.5147843	56	100.00	100.00
Total	56	100.00	

```
 .
 . // Summary statistics of the returns
 . sum ran4_ret
```

Variable	Obs	Mean	Std. Dev.	Min	Max
ran4_ret	55	.1010067	.1962064	-.3279105	1.145873

```
   Ran4 Post Outlier   Sunday April 14 22:22:26 2019   Page 3

29 .
30 . // Mean, Geometric mean of the returns. Must use positive values for geom. mean
31 . // SQUARE the biannual geometric mean to get the annualized geometric mean
32 . ameans(pos_ran4_ret)
```

Variable	Type	Obs	Mean	[95% Conf.	Interval]
pos_ran4_ret	Arithmetic	55	1.101007	1.047965	1.154049
	Geometric	55	1.087111	1.042546	1.133582
	Harmonic	55	1.075042	1.033963	1.11952

```
33 .
34 . // From the ameans:
35 . display 1.087111 * 1.087111  //ann. geom. mean for sin portfolio
   1.1818103

36 .
37 . // CAPM regressions for all of the portfolios.
38 . // Ran4 portfolio
39 . reg (exc_ran4) (exc_mkt)
```

Source	SS	df	MS
Model	.481094713	1	.481094713
Residual	1.59773829	53	.030146005
Total	2.078833	54	.038496907

Number of obs	=	55
F(1, 53)	=	15.96
Prob > F	=	0.0002
R-squared	=	0.2314
Adj R-squared	=	0.2169
Root MSE	=	.17363

Random 5 Portfolio Post Outlier

```
 Ran5 Post Outlier  Sunday April 14 22:22:48 2019   Page 1

                                    ___  ____  ____  ____  ____(R)
                                   /__    /   ____/   /   ____/
                                  ___/   /   /___/   /   /___/
                                    Statistics/Data Analysis

1 . do "C:\Users\Tyler-PC\Desktop\CurrWork_DT\tempdta\results\Outlier analysis\02 Remove Outliers an
  > ean.do"

2 . // Analysis of random portfolio 1
3 . // Master data set
4 . /* VARIABLES ALREADY CREATED. GO TO UNCOMMENTED SECTION.
  > import excel using "SeniorProj_Master copy.xlsx", sheet("master(3)") clear
  > duplicates drop
  > drop if A == "ident"
  > drop if B == ""
  > drop if B == "ticker"
  > drop if C == ""
  >
  > // Creates a numerical representation of date; days since 1/1/1960.
  > gen numdate = date(C, "MDY")
  >
  > // Destring and rename variables
  >
  >
  > encode(B), gen(ticker)
  > drop B
  > destring(I), gen(period) force
  > drop I
  > destring(D), gen(price) force
  > drop D
  > destring(E), gen(gics_code) force
  > drop E
  > destring(F), gen(mkt_cap) force
  > drop F
  > destring(G), gen(eth_mkt_cap) force
  > drop G
  > destring(H), gen(sin_mkt_cap) force
  > drop H
  > rename C date
  > rename A id
  >
  > //drop the outliers
  > drop if (id == "56") // 1448062D
  > drop if (id == "445") // CMCSA
  > drop if (id == "446") // CMCSK
  > drop if (id == "607") // FMC
  > drop if (id == "747") // KBH
  > drop if (id == "844") // MON
  > drop if (id == "958") // PHM
  > gen ran5 = mkt_cap if (gics_code == 15101030) | (gics_code == 15102010) | (gics_code == 25201030
  >  | (gics_code == 25401025) ///
  >
  > // Only re-doing ran5 portfolio analysis
  > drop if ran5 == 0
  > drop if ran5 == .
  > duplicates drop
  >
  > sort id numdate period
  >
  > // generates the groups used in calculating the returns
  > egen period_group = group(period numdate)
  > bysort period_group: egen ran5_cap = total(ran5)
  > // generates the return for each period
  > gen ran5_ret = ran5_cap/ran5_cap[_n-1] - 1
  >
  > drop if period_group >= 57
  > duplicates drop
  > egen numRan5CompInPeriod = count(ran5), by (numdate)
  > egen avgComp = mean(numRan5CompInPeriod) //avg =~ 19
  > tab avgComp
  >
```

```
Ran5 Post Outlier   Sunday April 14 22:22:48 2019    Page 2

  > // clean up sheet
  > drop if(ran5_ret == 0)
  > drop if(period_group>=57)
  > sort numdate period
  > save "05 ran5_outl.dta", replace
  > */
 5 .
 6 . // Regression
 7 . use "05 ran5_outl.dta", clear

 8 .
 9 . gen tbill2 = tbill/100
   (1 missing value generated)

10 . drop tbill

11 . rename tbill2 tbill

12 .
13 . gen exc_ran5 = ran5_ret - tbill
   (1 missing value generated)

14 . gen exc_mkt = tot_ret - tbill
   (1 missing value generated)

15 .
16 . gen pos_ran5_ret = ran5_ret + 1
   (1 missing value generated)

17 .
18 . // Calculate the sharpe ratios for each portfolio
19 .
20 . egen mean_ran5_ret = mean(exc_ran5)

21 . egen std_ran5_ret = sd(exc_ran5)

22 . gen ran5_sharpe = mean_ran5_ret / std_ran5_ret

23 .
24 . // Quick access to the sharpe ratios as output
25 . tab ran5_sharpe
```

ran5_sharpe	Freq.	Percent	Cum.
.1701755	56	100.00	100.00
Total	56	100.00	

```
26 .
27 . // Summary statistics of the returns
28 . sum ran5_ret
```

Variable	Obs	Mean	Std. Dev.	Min	Max
ran5_ret	55	.4301359	2.527585	-.9991362	18.69028

```
   Ran5 Post Outlier   Sunday April 14 22:22:48 2019    Page 3

29 .
30 . // Mean, Geometric mean of the returns. Must use positive values for geom. mean
31 . // SQUARE the biannual geometric mean to get the annualized geometric mean
32 . ameans(pos_ran5_ret)

    Variable |    Type             Obs        Mean       [95% Conf. Interval]
-------------+-------------------------------------------------------------
pos_ran5_ret | Arithmetic           55    1.430136       .7468339    2.113438
             |  Geometric           55    1.004324       .7527151    1.340038
             |   Harmonic           55    .0455423              .           .
---------------------------------------------------------------------------
Missing values in confidence intervals for harmonic mean indicate
that confidence interval is undefined for corresponding variables.
Consult Reference Manual for details.

33 .
34 . // From the ameans:
35 . display 1.004324  * 1.004324 //ann. geom. mean for ran5 portfolio
1.0086667

36 .
37 . // CAPM regressions for all of the portfolios.
38 . // Ran5 portfolio
39 . reg (exc_ran5) (exc_mkt)

      Source |       SS           df       MS      Number of obs   =        55
-------------+----------------------------------   F(1, 53)        =      1.34
       Model |  8.53275545         1  8.53275545   Prob > F        =    0.2515
    Residual |  336.456334        53  6.34823271   R-squared       =    0.0247
-------------+----------------------------------   Adj R-squared   =    0.0063
       Total |  344.989089        54  6.38868684   Root MSE        =    2.5196
```

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